Journal of the American Foundrymen's Association.

VOL. X. JUNE, 1901. PART I.

THE FOUNDRY, ITS EQUIPMENT AND MANAGEMENT

By MR. EDWIN B. GILMOUR, Milwaukee, Wis.

In the present age of progress, with the concentration of work and the reduction of prices to the minimum in all kinds of industries, and where the law of the "survival of the fittest" seems to assert itself, the idea has become prevalent among business men that it is not the largest percentage of profits that gives the greatest dividends, but that it is the largest output. In order that the foundry may keep pace with the other industries, it behooves foundrymen to adapt themselves to their surroundings and advance with the times in supplying the demand as it comes forth. This can only be done in building and equipping foundries on the most modern principles and getting rid of the idea that all that is essential is simply to have a crane, cupola and a drying oven, because to the unpractical mind this is about all that can be seen. These appliances are certainly the most important that are there, as is evidenced when visitors enter the foundry, the foreman showing with pride how fleetly his crane can run and how many movements can be made with it at one time; he will also revert to the cupola and expatiate upon its merits as a melter in quantity and quality. After a very careful consideration of this subject, and a large and varied experience in the foundry business in general, I deemed it advisable to submit for your consideration my ideas upon the title of this brief paper.

In the first place we will consider what a modern and up-to-date foundry should be when quantity and quick deliveries together are of greatest importance. The foundry should be built so as to have easy access to all other departments, especially the pattern shop and machine shop; it should be in a position to receive the greatest amount of light and air in order to dispell all of the obnoxious gases generated while casting; there should also be the greatest amount of comfort possible for the men em-

ployed therein, because in winter time, when it is excessively cold, you cannot get full value from the men when they do not feel comfortable, and in summer time, when it is extremely hot, if your place is not well ventilated, the men will very often walk home after the company has been at the expense to get up steam to run the plant. The accompanying sketch, "A," will give an idea of what I have designed and submit for your discussion. You will observe that I have adopted a system of building which may be called the "bay" system. A building of this description can only be used to advantage in a very large plant, or where a plant is put up with the expectation of enlarging from time to time. The main feature of this plan is to concentrate important operations as near to the center as possible, as a very long, narrow foundry may be a source of trouble by causing many delays, because one crane cannot pass on account of another being in use at some inconvenient place. It is desirable to have a crane equipped with double trolleys, the reason being obvious, for when there is a very heavy piece to make it is not practicable to put all the metal into one ladle, as this might be too heavy a load for one point on the crane, whereas if the crane has double trolleys a ladle can be suspended on each hook, which will amount to having two cranes. I have often seen three cranes used to pour a large piece, four ladles being used, one of the cranes taking two ladles (when one was emptied it had to be dropped down and another which was in readiness picked up). If the cranes had double trolleys they would have only used two cranes and done the work more expeditiously, thereby leaving the third crane free to take the iron away from the cupola and cause no inconvenience. In taking out heavy castings both hooks can be attached to a piece exactly as if two cranes had been employed. In the case of large molds, where two cranes are required (such as very large fly wheel molds), they can be lifted in the same manner. If at any time one of the motors should burn out you can hoist the block right up and run it out of the way, and use the other trolley until there is time to have repairs made, thereby avoiding the loss of time by having men waiting until the crane is in readiness again. In many cases where two cranes are used to roll over heavy molds one crane with two trolleys will serve the purpose just as well and save the inconvenience of keeping one crane waiting for the other.

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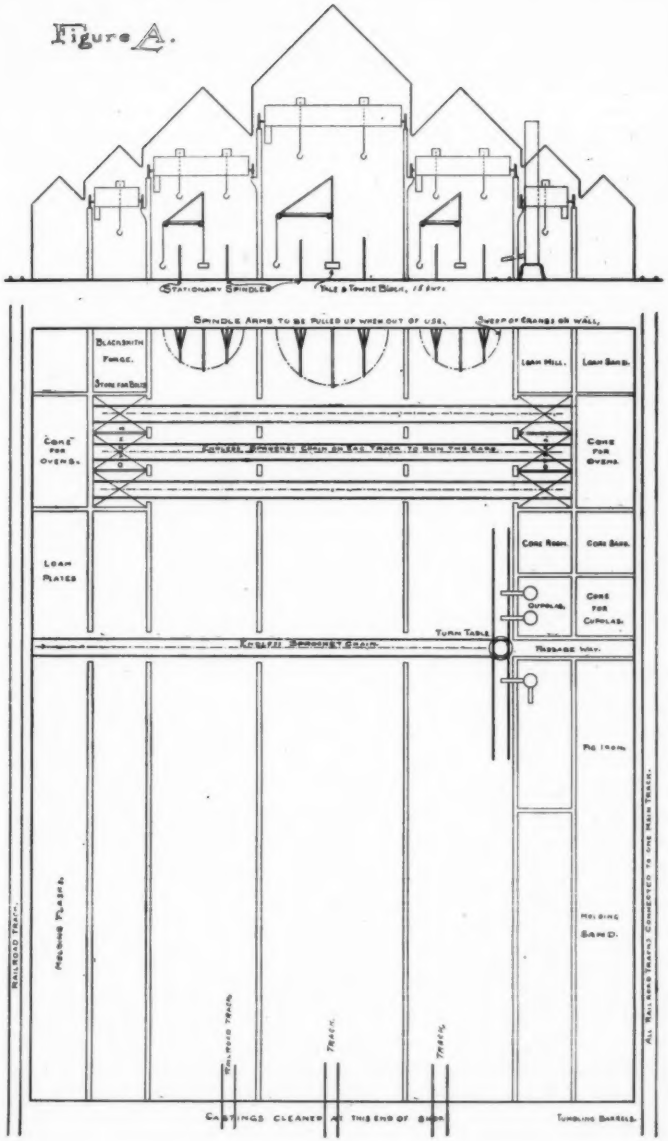
Figure A.


Stationary Spindles
Tale & Towne Bench, 18 Ft's.
Spindle Arms to be pulled up when out of use.
Sweep of Cranes on Wall.
Blacksmith Forge.
Stone for Bolts
Loam Mill.
Loam Sand.
Cores for Ovens.
Rollers, Grooved Iron on Bar Trucks to run the Cars.
Cores for Ovens.
Loam Plates
Core Room.
Core Sand.
Cupola.
Cores for Cupolas.
Knuckle Bronzed Chain.
Turn Table
Passage Way.
Pig Iron.
Molding Flasks.
Molding Sand.
Railroad Track.
Railroad Tracks
Track.
Track.
All Railroad Tracks Connected to one Main Track.
Castings cleaned at this end of Shop
Tumbling Barrels.

At the end of the shop there should be placed stationary spindles for loam work, a wall crane is provided between every two spindles in order to lift them as well as other light plates out and in, as desired, so that there will be no waiting for the large crane. These wall cranes can be rigged with a chain and Yale and Towne block of 1,500 lbs. capacity, and can be operated by hand or electric power. When the spindles are out of use they can be suspended to a short chain attached to the pillars, and the arms can be pulled up against the wall, well out of the way. The drying ovens are placed in the side wings, three at each side (or as many as may be desired), the tracks are run clear across the shop, so that a mold can be put under any of the cranes, so that all three of them can be used in connection with the same oven track at the same time if required. The cars are run out in the ovens with an endless link belt chain, a loose chain being hitched to the car with an "S" hook which can be attached to any link of the chain. Near the center of the shop are the cupolas, which are set up pretty high in order that an eight or nine ton ladle can be placed upon a truck and run undearneath the spout. When filled it may be transferred under any of the cranes, or it can be side-tracked and another ladle set under. The end of the shop is reserved for the cleaning of all castings, and a railroad spur put in far enough to load and unload trucks with each crane. The tumbling barrels are placed in line with the sand sheds, so that the noise and dust may be kept outside of the foundry. Double emery wheels are placed in the side wing, and benches provided with vises are installed in order to chip the small castings. On one of the tracks there can be placed a track scale large enough to weigh a regular flat car. All castings should be marked with the weight and date of making, and a record kept which can be referred to at any time in order to know the exact mixture of the metal used in them.

Attached to the foundry there should be a chemical laboratory, also equipped with a complete set of testing machines, in order to make all the required mechanical and chemical tests. I am of opinion that both are essential in all well regulated foundries. I also believe that it is necessary for a foreman in the foundry to be possessed of some chemical knowledge on the mixture of metals and other materials used in the foundry. This knowledge can be easily acquired by any one who is desirous

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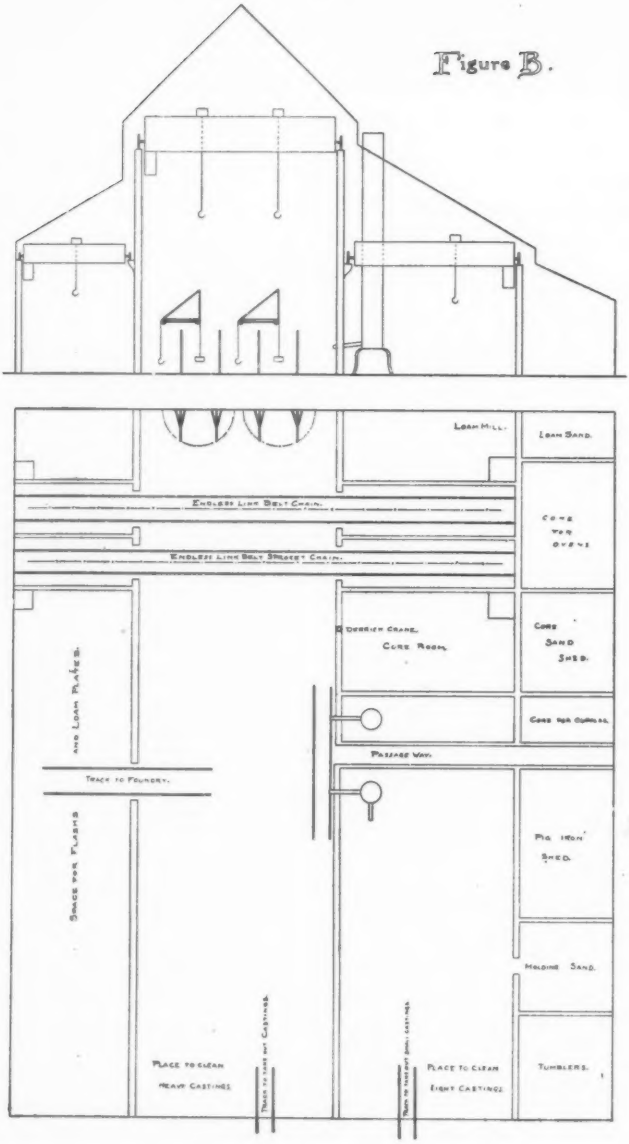
to receive the information, and I predict that in the future it will become one of the indispensable qualifications of any one who wishes to become a foundry foreman.

Along each side of the foundry is a railroad siding intended to distribute the coke to the ovens and the cupolas. The sand and other materials required in the foundry is placed in sheds built against the foundry wall, which serves to keep out the frost in winter time.

The cupolas should be provided with a regular system of trolley tracks and suspended trucks running from the pig iron sheds direct to the elevator, and from the elevator to the charging door of the cupola; each truck should hold a complete charge for the cupola. There should be a liberal supply of trolley trucks in order to save handling the iron too often. When these trucks are emptied they can be returned by the return track to be refilled. A scale can be arranged in connection with the trolleys to weigh the charges. The trucks can be raised and lowered upon the scale by means of a long lever suspended from the trolley. In close proximity to the scale there should be a blackboard with each day's heat properly recorded, having columns itemizing the mixture of each charge, and these charges should go in their regular order so as to prevent confusion. The order of the charges should be made out by the foreman each day and a correct entry recorded in a book provided for the purpose. With reference to the cupola there are so many designs in the market that show special advantages, and there have been so many able articles written upon this subject, that it would be out place for me, at this time, to revert to this subject in particular. In the August, 1900, issue of the "Foundry" I published an article upon the cupola, which was specially reviewed for the members of this Association by our Secretary. In connection with the cupola there should be installed a device which costs practically nothing to operate—the magnetic separator. A device of this kind is essential in a well equipped foundry where economy is studied, and I prefer the "Dings" Separator which is made in Milwaukee for my own work.

Sketch "B" is the plan of a foundry of smaller dimensions and more suited to fill the requirements of the average foundry at the present time. The main feature of this building is the presence of only two bays, one large and one small one, so that

Figure B.


Loam Mill.
Loam Sand.
Endless Link Belt Chain.
Endless Link Belt Shifting Chain.
Cores for Ovens
Derrick Crane.
Core Room.
Cores Sand Shed.
Cores for Cupolas.
Passage Way.
and Loam Plates.
Track to Foundry.
Space for Flasks
Pig Iron Shed.
Molding Sand.
Place to Clean Heavy Castings
Track to Take off Castings
Track to Take off Small Castings
Place to Clean Light Castings
Tumblers.

all of the small work is kept together, the benefits of which will be readily seen by the interested observer. The description already given of the large plant will suffice for the smaller one, as they are built practically upon the same lines.

Of the numerous subjects brought under discussion among foundrymen there are none more important than equipment and management. These are so closely allied that the success or failure of a foundry is determined by a proper understanding of them. There are no subjects which have been more discussed; yet withal the information is as much needed to-day as ever. In reviewing the history of the iron foundry there has not been so fruitful a change as one might have expected. The foundry has not made the great advances that science and the arts have made; indeed, I consider that among the various applications of mechanics the founder has the greatest need of incessant study. In every country and every locality that the foundryman has entered he is confronted continuously with new difficulties. In some sections of this country he has material which is suited in every respect to his requirements, consequently he has unbounded success in his work, while in other localities he is obliged to use materials which are unsuited to his business requirements; he has, therefore, to mix his materials in order to get the desired results. In general engineering there are certain rules to go by, which are the same the world over; the same applies to the draughtsman, the patternmaker, the blacksmith and all other mechanical lines. The workmen can also see the progress of their labors, whereas the molder is never sure of his work even after an engine built with it is working, because the castings may have some very severe contraction strains in them which are unknown until one of them unexpectedly gives way and surprises everyone.

The foundry business requires incessant study, as I have said, but it very rarely receives it, for when a bright boy comes into the foundry he very soon becomes dissatisfied on account of the nature of the work, it being hard and dirty, as everything in the foundry has to be produced by manual labor. Whenever this boy discovers any improved method for producing a piece, it is simply adopted as a matter of course in the shop in general, and he receives no credit for his study. Now, in the machine shop, if any one designs a machine to produce better and cheaper

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work, he may have his machine patented, and thereby be compensated, if not in money, at least in credit.

In equiping a foundry the manager should always be open to conviction and get the best tools which may be procured for the purpose at the lowest possible cost. In some large foundries it is customary to use a cross to lift heavy molds. Attached to this tool are heavy slings, which are made in many different styles. Some are simply huge links, and when these are used it is necessary to have a large assortment in order to suit the various requirements. Again, some foundries have slings made in a most ingenious manner, and which can be extended to any length, and serve the purpose admirably. The most improved method of lifting heavy molds, however, is with a steel beam, best made of an I section and suspended at the center. A double shackle or clevice, with a loose hook on each end, which slips out and in on the beam to suit the requirements, will be seen in

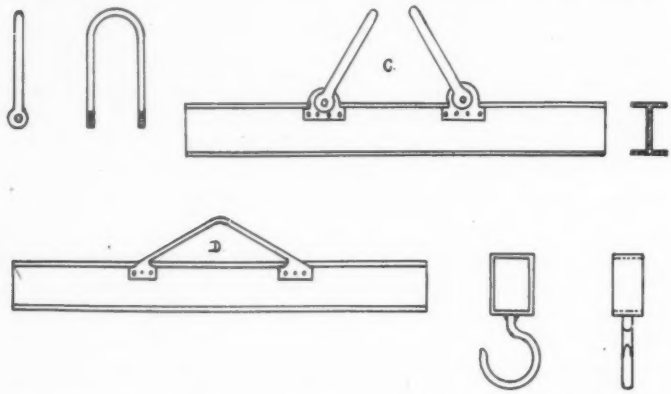


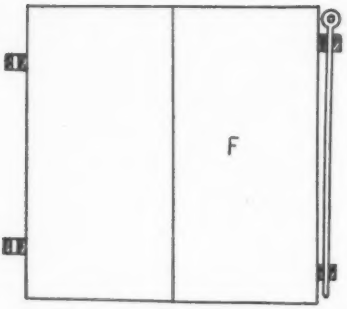
Fig. "C." The reason for using doubel shackles is that with an uneven load the beam is suspended directly with each half, independent upon the hook of the crane, whereas if you only use the single bar as in Fig. "D," at the least swing of the crane the load will roll in the hook and you run the risk of upsetting the mold which may be suspended. Chains of ample strength are suspended from these hooks, which are lengthened at will to suit the requirements by using the design as shown in cut "E." This is by far the most expeditious method of lifting heavy

Fig. E.

molds. The chains are more flexible and are light to handle, and the device takes up very little room when not in use. A good rule to go by in making these chain hooks is to double the size of the chain; thus for ¾ chain use inch and a half square iron bent over the diagonal section.

For the purpose of curbing, some founders use sheet iron plates about 72 inches by 30 inches, with a row of holes at each end in order to bolt them together. This is a very crude and slow method. Other founders use a cast plate made with lugs on the ends, so as to allow a pin to join the plates together. This plate, I believe, has been patented, and is made in various sizes to suit the requirements. Being of cast iron, they are very heavy to handle, but are very good. In my opinion the best and most practical plate for curbing purposes is simply to take a steel plate three-sixteenths of an inch thick, as is represented in Fig. "F." These plates are made 27 inches high and of various widths, to suit the circumstances, such as 36 inches, 24 inches, 18 inches, and 6 inches. For making runners it is advisable to have them 14 by 14 inches. These plates are very light, are easily transported from place to place and take up very little room in stacking up out of the way.

For binding or fixing molds together, bolts are the best. They can be made in various lengths, also lengthened to suit the



requirements by using reverse hooks linked in a triangle or sling, which is put over the lower handles. These hooks should be made 6 inches, 12 inches, 24 inches, 36 inches, and so on, in any length as desired, and should be made of no less size of iron than $1\frac{3}{4}$ inches.

In the green sand shop there should be a pleniful supply of gagers and an abundance of clamps and a place to put them. For all standard patterns there should be flasks for the purpose, with follow boards. All flasks which are too heavy for hand lifting can have trunnions bolted on the sides, so that they can be rolled over without lowering down; unless when too large, as they are then apt to spring a little. I have rolled very heavy flasks with trunnions, however.

When you enter a foundry at any time, the first thing which impresses itself upon your notice is the nature of the management, this being shown up by the general appearance of things. You will very often see in the loam shop portable spindles laying about in all directions, and being used for crow-bars and various other purposes. The same applies to all other tools. In the green sand shop you will find flasks piled up in all directions, molders will be seen hunting all over the yard looking for flasks, and when they find one that will suit it is carried into the flask shop to have it refitted for the pattern.

In this age of economy it is not practical to have molders do work which can easily be done by the helper. All flasks should be fitted to the pattern before being brought to the molder, all facing sands should be mixed and sifted by a power sieve and brought to the molder. The iron for casting should be carried by large ladles or conveyors, so as to be handled quickly and

cheaply. The castings should be taken off the floor at night, and the sand watered and cut up ready for use when the molder comes to work in the morning. The same rule applies to the loam shop, as molders are better satisfied to do only molding work. It is a good practice to have two men follow the crane and lift all work under the guidance of the molder making the piece. These two men will endeavor to locate all work in such a way that it will be for the general good. The manager should have complete control of his men. He should not become too familiar, as familiarity breeds contempt. He ought to be a good mechanic and competent to give advice whenever it is required, and not afraid to assume responsibility. Whenever orders are given they should be definite and decisive, because when orders come from one in command which are not decisive the men who receive them become careless and pay little attention. To a man possessing the requisite qualifications to become a competent manager a liberal salary should be given, because the success or failure of the company is determined by a proper knowledge of the business being entrusted to him, even if the company has unlimited capital.

In the management of the foundry there is nothing of more importance than to have a correct accounting of all that transpires. This can only be accomplished by a regular system of bookkeeping, so that the foundryman can intelligently estimate on whatever contracts may be upon the market. There should be a storeroom for the foundry, and all materials should be checked by the storekeeper, who should also be supplied with a regular set of books for recording everything. There should be a proper place for everything, so that he can hand out the goods as quickly as possible, and not have men lounging around the window. Whenever supplies are given out, he must record them against the job and the individual, and when the person knows that everything is recorded against him he will be very careful not to be wasteful. This storekeeper can also check up all castings which are delivered to the different departments, and in return take a material slip properly signed by the party receiving such castings. At the end of each month these books are balanced, and the cost per pound of every casting noted. An average cost of all castings should also be made, so that the foreman can instantly know how the foundry is doing, and if there should be any discrepancy he will know just where to locate the trouble.

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FOUNDRY COSTS.

By MR. R. C. CUNNINGHAM, Holyoke, Mass.

There is no subject in which every foundryman is as much interested as that on the reduction in the cost of his castings. It confronts him as a commercial problem, for, in these days of close competition, he must know how to make castings at the lowest possible cost in order to be a successful competitor in the market.

To the makers of moulding machines we are greatly indebted for the reduction in the cost of castings, as well as for the increase in production. Now, we will take the means they use to make their machines a success and apply them on work that is to be done by hand and see if we can not arrive at almost the same results.

Every maker of moulding machines claims that in order to get the greatest benefit from a machine, the patterns and core boxes must be perfect. Would it not be well for foundry-men to follow this example on all patterns sent to the foundry? If it is profitable to spend money on a machine pattern so that when it leaves the mould there is no further work to be done, would it not be much more so as to have all patterns properly constructed and thus reduce as much as possible the skill that is required in hand moulding.

It is the same in regard to core boxes. These should be so constructed that when a core leaves the box it will be perfect. It will not take a pattern maker any longer when doing this work to make it right than it will to do it in the slip-shod way in which we often find patterns made. I do not mean by this that a pattern maker should spend as much time on a pattern from which you want to get only one casting, as he would on patterns that are to be used continuously: it is our standard patterns that we want made as well as our machine patterns. By doing this we can greatly reduce the cost of our castings. It is admitted by all that there is a limit to work that can be done on machines.

Let us assume that the cost of work now done by machines is as low as can be made possible; then we will turn our attention to the patterns which are not considered practical to be used on machines. Some of the patterns are so large and complicated that it would require the services of a skilled moulder to do the work; the remainder is ordered in such small quantities that it would not pay to have the patterns fitted up for machines. It is to these classes of work that the foundryman must turn his attention in order to make a still further reduction in the cost of castings.

Let us take the work that is considered too complicated for the machines. When these patterns were made was the best and cheapest way to mould them thought of, or, did the pattern maker make the pattern the easiest way for himself, without thinking of what it would cost in the foundry? It is safe to say that in nine out of ten times the requirements of the foundry were not considered, and in consequence, the cost of moulding was nearly doubled. This could have been avoided had the foundry foreman been consulted, and the chances would have been that the castings could have been made at a minimum cost. If your foundry foreman is not capable of giving instructions as to how a pattern should be made to be moulded at the lowest possible cost, you are standing in your own light by keeping him in that position.

A short time ago a pattern for a large bed of a pumping engine was sent to a foundry for five castings, each of which would weigh several tons. The foreman objected to the way the pattern was made, as he claimed it could be moulded much cheaper if constructed in a different manner. After many arguments he was told to make one casting the way the pattern was made, then if he wished to have it changed, it would be done. It took a moulder and a helper seven days to make the casting. The pattern was then changed and the same men made it in four days. The cost for moulding the first casting was $31.50, while the last four were each made at $18, a gain of $13.50 a piece.

Another pattern which had been used a long time and from which hundreds of castings had been made took a moulder, working at the rate of $2.50 per day, a day's time to make sixteen castings. The moulder, working at this rate, would make the castings cost a little less than sixteen cents each. This pattern

was changed at a cost of $3.50 and then a laborer made one hundred castings for $1.25, the cores cost seventy-five cents, making the castings cost two cents each. This work was not done on a machine. If it had been, would not the machine makers claim that the machine was the cause of this reduction? I could cite hundreds of cases similar to these, where by making a few alterations on a pattern the expense of moulding was cut in half, and I think every foundryman will agree with me, when I say that more attention should be given to the construction and care of patterns.

If you will notice the condition of patterns that go into your foundry from day to day, and see the extra amount of work that has to be done on the mould to put it in the condition that the pattern should have left it, you would not be surprised at the high cost.

If our machine shop costs are greater than we think they should be, we lose no time to look for new and more modern tools with which to do the work. If our foundry expenses are high, are we not inclined to think that the foreman has been neglecting his business? Has it ever occurred to you that you are to blame for the increased cost? Are you not asking your foreman to turn out good work with poor patterns and flasks? Are you doing anything to help him to reduce the cost, or are you not asking him to do work that belongs to the pattern shop? The moulder has to do this work every time a casting is made from a poor pattern. Had the pattern maker done his work properly, there would have been no occasion for this extra moulder's work.

Give the same attention to your foundry as you do to every other department of your works. A labor saving appliance is as much to your benenfit in your foundry as it is in your machine shop. A dollar made in your foundry is as good as one made anywhere else about your works. Because the foundry is dirty and smoky do not neglect it, give the men every convenience to do their work with, costs cannot be reduced by compelling men to work at a disadvantage. Think of this sometimes when you send into your foundry badly made and worn out patterns, and old broken castings, a few strips and sweeps, for, when such is the case, how can you expect to get nice castings made from them.

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I wish to bring up another point. Are we not asking our moulders to do work that a laborer could do? In the majority of shops the men commence work at seven o'clock. How many do you find moulding much before eight o'clock. They have been one hour doing work that the laborer should do, while they should have been moulding. The average pay for the best moulders is thirty cents per hour, while the wages of the laborer is twelve and one-half cents. Every hour you have a moulder cutting sand you lose 17½c. If you have fifty moulders, you start off every morning by losing $8.75. How many have ever thought of this. Many are under the impression that you cannot get any more work done by having everything ready for the men when they come into the shop. If you have a moulder who will not do any more work by having his sand cut up, than if he had done it himself, he is not a profitable man to have in your shop, and if your foreman is unable to get any more work done by having the men commence work at seven o'clock, than he could if the men had cut up their sand and had commenced work at eight o'clock, he is not the man you should have to superintend your foundry. If you furnish your foreman with patterns properly made and necessary tools with which to do the work, you certainly have a right to expect your castings made at a reasonable cost. He must plan and lay out the work for the entire shop, so that their will be no time lost, and it is his duty to see that the men have the proper rigging with which to do their work, and also to insist upon work being done in the proper manner. He should never start a job until it is ready. It is the habit of some foremen to start a job and have the carpenter bar up the flasks afterwards, while the moulders are compelled to stand around and wait for him. From my experience I have learned that the majority of moulders would be just as well pleased to wait for a new flask to be made after they got a job started, provided they do not lose their time.

When you have a foreman who has no system about his shop you can always look for a small production, which always means high costs. Such a man is never successful as a foreman.

To be successful, a foreman of the foundry must be a mechanic, capable of deciding any question that is brought before him regarding foundry matters, and if he should be called into the machine shop to be shown a defective casting, he should be

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able to tell the cause of the defect and know where to apply the remedy, whether it be in the moulding, coremaking, or cupola. A knowledge of chemistry is of great benefit to a foreman, in fact, only by knowing the chemical analysis of what goes into the cupola, can he hope to obtain the desired results. When he knows the results obtained and the chemical combination which caused them, he knows that a reproduction of the same combination under the same conditions will reproduce the same effects, or in other words, like causes will produce like results. With this knowledge he can choose irons that will produce a mixture of any desired analysis at the lowest possible cost. A foreman must be a good judge of human nature, so as to be able to manage his men in a manner that will induce respect for himself; he should never lose his temper, or make use of profane language while talking to his men; he should not have any favorites, or to stop one man from doing what he allows another to do; if he makes a rule he must enforce it, and so show his men that he is managing the shop and not they.

There is no trade that requires the skill, patience and good judgment that moulding does. It is often pursued under the most wearisome conditions. The result at best is an uncertainty. Often times it is several days before a defect in a casting is discovered and then not until there has been dollars worth of machine work done on it. For this reason we should have the best of everything with which to do our work. We should not be asked to "make bricks without straw," but supply us with good material of all kind, and then you can expect good results. The sooner the foundrymen realize this, the sooner they can look for a greater reduction in the cost of castings and an increase in the output from the foundry.

Journal of the American Foundrymen's Association.

VOL. X. JUNE, 1901. PART I.

THE RELATION OF THE LABORATORY TO THE FOUNDRY.

By MR. PERCY LONGMUIR, Sheffield, England.

The question of chemical analysis and the advisability of mixing iron or other metals on the result of such analysis is one of keen interest to founders, and one that will profit greatly from a free discussion and interchange of opinion. In most of our industries, practice or rule of thumb has preceded science, and especially is this the case with foundry work. No one can gainsay the good and in many cases excellent work done by these methods. Our thoughts immediately turn to the early days of founding, and we are compelled to admire the splendid examples of such castings, and, at the same time, to wonder how they were produced with the appliances then at hand. May not our successors, a few generations hence, have the same thoughts concerning us and our methods? It is easy prophecy to assert that by that time laboratories will be regarded as a necessary part of foundry equipment.

In steel works practice of to-day the chemical laboratory is recognized as an absolute necessity. Complete analyses of each Open Hearth cast or Bessemer blow are taken. The advantage of chemical analysis in the case of Open Hearth steel is most apparent, for by its aid any temper of steel can be produced, and the furnace held in perfect control. This is more readily grasped when we realize that a sample can be taken from the furnace, drilled when cold and analyzed for carbon by the Eggerts' test in something under 15 minutes. This test is naturally rapidly performed, but it does not follow that rapidity involves inaccuracy, for in good furnace practice the carbons in the resulting ingots or castings are found to come out correctly with almost unfailing regularity. It must also be remembered that these steels are produced to within 1-10 of 1 per cent. the requisite carbon content. But the efficiency of a steel works laboratory does not end with the conduction of complete analyses of each furnace heat or the estimation of combined carbon in furnace samples. All raw

materials, furnace bricks or linings, fuels—solid and gaseous—iron ores, pig irons, etc., are subjected to a vigorous chemical examination which determines their suitability or otherwise for the purpose intended.

The acknowledged success of the steel works laboratory has caused many foundries to view chemical analysis as a means of controlling and regulating their mixtures and many foundries have adopted this plan with more or less success. In the older days mixing iron by fracture only met with a much larger measure of success than is possible to-day. The brands of iron, mostly charcoal, were fewer and they did not vary to the same extent as those the founder of to-day is compelled to use. To-day the founder controlled by competition must utilize much cheaper irons, and this same factor compels him to turn out a casting equal in every respect to one made from a mixture of charcoal and cold blast irons. To do this by fracture only is out of the question. The deceptiveness of a fracture has been shown by many writers, and it is well known that its appearance is influenced by the rate of cooling and also the initial temperature of the iron. Further than this the same grade number of iron from different furnaces will only, in rare instances, have similar chemical or physical properties, and hence mixing by the grade number only is impracticable. There are two courses still open, and these are mixing on the results of (1) Chemical analysis; (2) Physical tests. A series of the latter can be readily conducted in any foundry, much valuable information derived therefrom and a methodical plan of mixing adopted. No matter how ingenious this system be, it still leaves much to be desired, and it is only in a combination of physical and chemical analysis that full information of the characteristics of a metal will be gained. It is to this combination that the founder of to-day must turn and in it will find many scientific "short cuts" to that excellence of product which means full employment and fair dividends.

The routine work of a foundry laboratory comprises the analysis of every new batch of iron, the results of which are handed on to the foundry manager, who calculates his mixtures from these results. Complete analyses are necessary; that is to say estimations of combined carbon, graphite, silicon, manganese, sulphur, and phosphorus. With a laboratory at hand, all iron should be bought to specification and on conditions that if cer-

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tain elements exceed or do not reach a certain percentage, the shipment is liable to rejection. Each founder must, of course, make these specifications cover his own requirements. The metallic alloys in use in the foundry are bought in the same manner and checked by the chemist. These include ferro manganese, speigel, aluminum, ferro-aluminum, ferro-tungsten, ferro-nickel, etc. If a brass foundry is attached to the establishment further duties for the laboratory include the analysis of copper, tin, zinc, and the various alloys and deoxidisers in use as phosphor-copper, phosphor-tin, cupro-manganese, etc. Foundry materials, such as blackenings, plumbago, etc., sands, clays, fire bricks and ganisters are examined for impurities, or in the case of facing adulterations. Fuels are examined and particular reference paid to the amounts of sulphur and ash.

The conduction of mechanical tests should come under the chemist's supervision. With cast iron these are generally limited to transverse tests, but a strong plea might be held for more tensiles, and the writer would suggest that such a test accompany each transverse test made. It is true that most of the strains cast iron has to meet in actual working life are transverse ones, and also that this test is easily performed, but if a testing machine be at hand, a tensile test will be readily performed, the expense trifling, and the gain in information great.

Physical tests of contraction, crooks, fluidity and chill made in the foundry are reported and tabulated by the chemist. In this correlation of chemical, mechanical and physical properties, lies the true secret of a perfect mastery of the mixing and melting of iron or any alloy. The results of the chemist's work, correlated and tabulated are kept in such a manner as to give any desired information at a moment's notice. In the case of abnormal results the microscope reveals much information as to crystalline structure. Metals or alloys of high electrical conductivity are in request and a combination of chemical and microscopical analysis will show the path to success in this direction. This leads to the matter of experimental work, and it is hardly necessary before an association of founders to lay a plea for original research. It is a difficult matter to specify the probable results of such work, but in the first place no financial loss accrues, light is thrown on dark subjects, and paying specialties or novelties are found.

The conservative element is strong in many foundries and this accounts for much of the opposition laboratories have to meet. Changes which apear at all revolutionary are looked at with askance. The matter is not one of expediency, but rather an indifference to change from the customs bequeathed by our ancestors. In other respects foundry work is looked upon as "no class," that is as being inferior to and requiring the exercise of less judgment than other branches of the engineering profession. In a case of this kind the laboratory is regarded as being "too academic," and as having the tendency to lift the foundryman from his natural rut and place him on a plane nature never intended him to occupy. Criticisms of this kind generally emanate from a source where the idea of moulding is that of raming sand, and of melting that of throwing pig and coke into a furnace and drawing off the liquid iron from the bottom.

Many are sceptical as to the value of a laboratory and argue that there is no return for the money invested, or, in short, that the laboratory is a mere scientific "fad." We will take an example from the brass foundry first. Assuming that our imaginary brass foundry purchases 30 tons of copper per month, what guarantee has the purchaser—further than the brand—of its purity? Suppose this copper to contain 1½ per cent. of zinc, how many fracture experts would detect it? It will not seriously affect the castings, but it makes a difference elsewhere. The yearly purchase of copper will be 360 tons, representing, at $370 per ton, $133,200. But this copper is associated with 1½ per cent. zinc, and the cost of zinc is about $90 per ton; 1½ per cent. of 360 tons represents 5.4 tons, which should have cost $426, but for which were paid $1,998, an excess of $1,512.

This illustration is a fictitious one, and may be slightly overdrawn, but it points a moral. Chemical analysis would, in this case, save the founder over $1,500, and he can add all the zinc necessary himself. It is well known that some varieties of copper will carry more zinc than others; that is to say, will not show it in color so readily, and in this respect chemical analysis would doubtless yield some information.

Another example may be quoted, and this is an actual one. A reverberatory furnace and a length of underground flue were built and no advice sought on the simple matter of brick. The design of the furnace was bad, but the bricks were worse—they

were made of the commonest of clay, and the flue built of ordinary red brick. The bricks softened and formed a good slag at the working temperature of the furnace and needless to say the life of that furnace was not very long. An analysis of these bricks for lime work, potash and soda would have saved much loss and demonstrated most forcibly the utility of chemical analysis.

An inquiry appeared recently in one of the technical magazines for a suitable varnish or coating to paint the interiors of iron castings in order to make them meet a certain hydraulic pressure, which, by the way, was not at all high. The aid of chemical analysis should have been called in in this case, and the composition of the iron adjusted until the castings would meet the requisite pressure without leaking. Instances of a similar nature to the three already given can be multiplied, showing the financial gain or rather the prevention of financial loss due to the laboratory, and proving that the money sunk in such an institution is not by any means so unremunerative as many appear to think.

An objection often raised against chemical analysis is that the results are not reliable and that no two chemists return concordant analyses of the same sample. There may be more or less truth in this, but it must be remembered that drillings for analysis are often submitted in a careless manner, and many cases of varying results from different chemists can be traced to this cause. The importance of correct and uniform sampling cannot be too forcibly maintained. Cases have occurred in which drilling taken from opposite ends of a pig or even from different pigs have been sent to different analysts and the results expected to coincide. On the other hand few chemists realize their own "personal equation," and most of them have their own standards or methods. There are many inherent difficulties in the laboratory which contribute their quota to the chemist's troubles, and which, perhaps, are hardly realized by outsiders. The work of this association will do much toward alleviating and removing these troubles, and it is hardly necessary on this occasion to refer to the work of the standardization committee. The writer will venture to say that this committee, by supplying reliable standards, in addition to the great boon conferred on chemists will do more to favor the introduction of the laboratory into the

foundry and to establish a firm confidence in chemical analysis than any amount of papers or discussions.

It is urged that many iron castings meet all requirements if they are true to pattern, clean and solid. This may be true of a sash weight, but it is not by any means the case with castings for engine details machine framings, hydraulic or steam purposes, nor yet with structural castings. Other properties are requisite in these cases and in this competitive age the founder's aim is to meet these requirements without recourse to expensive brands of iron. The laboratory offers a solution of this and similar problems, by means of this establishment the founder is enabled to meet any requirements in his castings in the most economical manner.

The direct outcome of the laboratory will be the abolition of rule of thumb methods in mixing metals, it will replace these with scientific and exact ones and set the art of mixing and melting on a higher and more stable plane. The days of special fluxes, fakes and nostrums of various kinds are surely drawing to a close and what we need in this 20th century is clear light with definite and exact methods. There is no flux known that will remove the uncertainty of foundry work. Chemical and physical analysis do not accomplish this either, but by their aid many risks are removed, suitable metals are ensured in the various qualities of casting, and they tend to keep things in the foundry ever on the upward trend.

The founder of to-day who would turn out his castings of one uniform standard of excellence must, of necessity, put himself in a condition to profit from the results of chemical and mechanical analysis. A chemical analysis, tensile or tranverse, test, contraction, warping or fluidity tests must not represent so much Greek, but rather should give exact information and enable the founder at once to determine the suitablity and extent to which the metal giving such tests may be beneficially used. The founder with such information at his finger ends, and the ability to use it need fear no rival, he has reduced his business from one of uncertainty to a scientific exactitude that can face all competition in that respect.

The success of a laboratory in any large foundry is assured, and if the output of a foundry be too small to warrant the retention of a chemist, recourse may be had to outside analysts, and

all physical tests can be readily conducted in the foundry with comparatively little outlay and the existing personnel.

The future of all foundry work depends upon the development of scientific methods, and from the foothold these methods have already obtained we see the dawn of an era which will be distinguished by the great advance of the whole foundry industry.

Note by the Secretary: Through the courtesy of Prof. J. O. Arnold, of University College, Sheffield, Mr. Percy Longmuir has been able to transmit to us a full specification of laboratory supplies required in an iron and steel works. The prices being in English money, it is inexpedient to add this list to the paper above, especially as all our large supply houses issue similar memoranda. The information, however, will be cheerfully furnished to any of our members who will inform the secretary of their desire in this direction.

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THE VALUE OF MIXING BY ANALYSIS.

By MR. JAS. A. MURPHY, Erie, Pa.

The great wave of prosperity that swept over the country two years ago ought to be forever a warning to American Foundrymen to abandon primitive methods of working particularly when it comes to the mixing of irons. The modern foundry made money during that time, while the shops run on the old principle lost its right and left. As long as the old-fashioned foundryman got the kind of iron that he knew from experience would give him certain results he got good castings; but when the demand for pig iron became so great that foundries were glad to get any kind from No. 1 to No. 3, and of any analysis, their troubles commenced. Castings ran honey-combed, cracked, were too soft, too hard, or had many other blemishes that wore the earmarks of bad mixing.

All this could have been changed if the managers had known how to mix by analysis. It is not a hard matter to learn, and foundry owners should insist on their foremen having that knowledge, for without it at the present time they are not fully competent to be foremen at all. One thing foundrymen should do, and that is, when buying irons to insist on the furnace furnishing a full analysis, and also insist on the coke manufacturers furnishing the sulphur of each carload of coke. This, of course, applies to the smaller shops who cannot afford to keep a laboratory of their own, and whose volume of business is not sufficient to warrant them buying entirely on specification. Some furnaces are not strictly honest when it comes to giving an analysis, and these seldom or ever gives it unless it is asked for, probably written for two or three times, and then comes something like this: Gentlemen: The last car of iron we shipped you analyzed as follows: Graphitic carbon, 3 to 4, Combined carbon, .25 to .65, Silicon 2 to 3, Sulpur, .01 to .023, Phosphorus, .40 to 1.60, Manganese, .50 to .70. Who could put up a reliable mixture from such an analysis? Again silicon and sulphur seem to be all the furnaces

care to furnish. Those of course are very important elements, the most important in putting up a mixture, but a knowledge of the carbons and the proportions in which they exist in pig metal is desirable in mixing for high grade work.

Here it seems to me the American Foundrymen's Association might step in and help those of its members whose establishments and business are not large enough to justify the expense of a laboratory. To me it seems possible that in connection with the present standing bureau a national laboratory could be established for the dissemination of chemical knowledge among foundrymen, where they could have those requirements studied and reported upon free of charge or for a nominal sum. The establishment of such an institution would certainly make the furnaces pay more attention to their product, and we could depend with greater assurance on our mixtures made from the furnace analyses furnished us. The larger coke manufacturers pay no attention to the specifications of small foundries, but send them anything at all that looks like coke. Coke can be made and furnished in quantities with sulphur running below .75 to large foundries that have a laboratory and buy on specification, but to us who cannot afford such things a coke running from 1.00 to 1.50 in sulphur is sent. To get good machinery castings with such coke requires the nicest manipulation of mixtures and cupola practice, and then there is more or less loss on this account. The association could be of considerable benefit to its members in this direction.

Large and small foundries should buy their iron and coke on specifications and reject what does not come up to them. If this were done universally, the "ovens" would use greater diligence in keeping down sulphur and would send out less burnt and slaty coke to give us trouble and dirty castings.

Many good foundrymen of the old school are under the impression that mixing by analysies is a "hobby" and the knowledge of metallurgical chemistry a superfluous attainment. The sooner they overcome of this idea the better. Mixing by analysis is the only correct and reliable way to get desired results, and the sooner it is universally adopted the more uniformly good will be the castings made.

There are many who complain that they cannot get the foremen to mix by analysis and that the chemist is not practical

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enough. It is very true that the general run of foundry foremen are entirely ignorant of such things, but the reason lies in the fact that until recently there has been no demand for such men. Create the demand and "young America" will fill the deficiency. There are many young moulders studying metallurgy at the present time, and from their ranks will come the foundry foremen of the future. The tact and knowledge of the new school is sure to supersede the rule of thumb methods of the old.

No more opportune time or place can be selected to lend emphasis to the very able and practical suggestions relative to the grading of pig iron in a recent paper read before this association by Mr. Thomas D. West. His method would bring order out of confusion and make the mixing of irons easier and more reliable for us all. This could be the more readily done were all our foundries mixing iron according to modern methods. The foundrymen and they alone can change the methods of grading irons. As long as no demand is made on the furnaces for grading by chemical analysis they will not trouble themselves about it. Probably they know only too well that it is a waste of information and a postage stamp to send it to 75 per cent. of the foundries of the country. This should not be when good literature on the subject is so easily obtained.

'Tis a common occurrence when buying, say six car loads of one brand of iron, to have each and every one of them a different grade when they arrive at the foundry. At best such things tend to confuse the foreman, and he that does not know anything of chemistry is going to have trouble and lots of it. Of course some foundries can use anything that they can pour out of a ladle in their castings, but it is only to shops doing high grade work that I refer. The more progressive element in the foundry business to-day would be glad if this convention would do something towards emphasizing Mr. West's suggestions on the grading of pig iron.

APPENDIX.

It may interest our foundrymen to give my method of recording pig iron shipments, and I therefore append an extract from the receiving books. While this may look very incomplete,

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nevertheless it furnishes the information requisite to put up a mixture very quickly:

Car No.	Date Rec'd.	Plie No.	Brand.	Grade	Si.	S.	P.	Mn.	Remarks.
1,382	Jan. 8	3	Seneca	5	1.73	.019	.30	.60	
8,240	" 27	14	"	4	1.90	.019	.31	.60	
9,654	Feb. 3	6	Hubbard	3	2.52	.013	.40	.50	
10,968	Mar. 8	1	Globe	..	6.00	.....	.....	.....	Softner
9,240	April 13	7	Rockwood	1	3.00	.02	1.50	.30	
50,864	Mar 10	8	Cherry Valley	5	1.75	.013	.....	.....	
126,890	April 20	13	Hubbard	2	2.80	.011	. . ..	.....	
42,068	Mar. 19	4	Seneca	4	1.40	.013	.....	.....	
60,844	Jan. 28	16	Ashland	...	5.50	.....	.....	.....	Softner
90,017	Feb. 9	9	Buffalo	1	3.15	.01	.60	.20	

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THE PROBLEM OF THE MOULDER.

By MR. JOHN G. SADLIER, Springfield, O.

Moulding is probably one of the oldest and most ancient of arts.

There are many evidences of this found in the ruins of prehistorical times. The Colossus of Rhodes, the gigantic copper man as a light house was so large that one leg stood on one promontory, and the other on another, and it was high enough to permit the ships of that time to pass between. This was supposed to be one large copper casting.

Then come the idols of the Buddhists which are estimated to weigh in the neighborhood of four hundred tons each. These are another great evidence of the perfection to which the art of moulding had been brought amongst the early Chinese and Japanese.

Next are the columns in the Temple of Solomon, which were most magnificent in their architectural design, as well as in their mechanical formation. Then we have in more modern times the Great Bell of Moscow, which certainly must have been a gigantic undertaking at the time in which it was made. The heaviest casting in modern times, of which we have a record, is an anvil block cast in Russia some twenty-five years ago, the estimated weight of which is said to be five hundred and fifty tons. The heaviest casting made in America is an anvil block for the hammer at the Black Diamond Steel Works in Pittsburg. Next to this is the steel cylinder of the large hydraulic press, for pressing out armour plate at the Carnegie Works at Homestead, weighing one hundred and forty tons.

Although there have been a number of large and excellent castings made in this country, yet the progress in this direction has not kept pace with the advancement in others. In the last fifty years the advancement in machinery construction has been so rapid that it appears almost phenomenal. From the old-time operating hand machine we have come to the improved automatic machines, which almost cover the entire range of manu-

facturing where there is a great number of one kind of piece to be produced.

Then again, in the case of the carpenter of the present day, there is very little to connect him with the carpenter of fifty years ago. At that time the lumber was furnished rough to the building lot, and was dressed and fitted together by the hand. To-day we have machinery with which all this work is done, and what is left for a carpenter is to fit and to fasten the already finished work together. The foundry alone appears to stand very nearly where it stood years ago. The reasons to be assigned for this, we would divide into two classes:

First, the increase of specialists. It seems to be the aim and object of many proprietors to teach their apprentices or beginners to make one piece, and when they succeed in making that satisfactory, to keep repeating the operation from year to year as long as they will stay in their employ. In many cases the apprentice becomes tired of this state of affairs, and seeks employment elsewhere; and if he secures it and is able to hold his position at all, he will be given the most inferior and simple work in the shop, for the simple reason that he has probably been tried on something better, and has failed to give a satisfactory result. Once he has been relegated to what is known as the side floor in a shop, it is very difficult for him to get a change. The result is, he will never rise above a third or fourth-class mechanic.

The second and great reason for the slow advancement of the foundry is found in the peculiar characteristics of the business itself. There is nothing in the way of mechanical arts or mechanical sciences that requires more thought, more mechanical skill, and more skillful practice. In all the other trades and professions there are rules, tables, gauges and fixed and systematic order, that can be and are applied to the different requirements, besides these a great amount of literature well and ably written, giving full and detailed instructions as to the quickest, safest and best method of accomplishing certain results. Tables on strengths, tables on pressure, tables on measurement and many others that are used are the result of ages of experience and practical test. All these fall short when you come to apply them to moulding, as that is learned almost entirely by the sense of feeling, a sense which can not be transmitted to another, nor can it be transferred to paper. It is something that must be ac-

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quired by actual practice. The sense of touch plays such an important part in the construction of a mould, that without it it is impossible to construct a mould with any reasonable expectation for success.

The feeling of the sand for its proper temper, its adhesive qualities, and as to its porosity; then in ramming, the moulder's sense of feeling should be trained to such a degree that he can tell at every stroke of the rammer whether he struck the bottom with sufficient force to ram the sand to stand the strain of the iron, or to prevent it from crumbling if dried, or to lift well in those parts which are to be raised off.

The material handled by the moulder is of a very delicate nature, and is easy to disarrange through a very slight mistake in any way. Then again, the iron delivered to him is very frequently too dull to make clean, sound, perfect castings and consequently his labor is all in vain.

If the clerk in the office in adding up a column of figures makes a mistake, it will show up in the trial balance for correction. If the pattern maker makes a mistake in a pattern, a little beeswax, putty, glue, a stick of wood with a jack-knife and chisel, will correct the mistake, as it is at all times apparent to the eye. The material from which the patterns are constructed are of a very solid nature that will not crumble away with the slightest touch of the hand. Many of the mistakes in the machine shop are overcome by fitting another piece to the one that has been spoiled, as in an error in measurement. In the foundry, a slight mistake or oversight will cause the entire day's, and sometimes the entire month's work, to go to the scrap pile. A mistake or oversight here can not be seen in time to correct, consequently the moulder is looked upon as careless and indifferent. He has probably made two moulds from one pattern as near alike as possible; the casting from one will be a beautiful thing to look at, and the other will probably be a mis-shaped, ungainly candidate for the scrap pile.

The best method to overcome these difficulties would be to leave nothing undone to educate the apprentice after he has secured a position in the shop in which he proposes to learn moulding, as complete as possible, through his course of apprenticeship, until we land him on the highest rung of foundry fame.

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And in doing this we hope, in a measure, to solve the moulder problem.

Before starting a boy in the shop as a full fledged apprentice, I would ask my colleagues in the foundry business to take this applicant for foundry honors on a probation of, we will say, three months; during which time he should be continually under the eye of the foreman, or his assistant, and watched very carefully without interfering or in any way coercing his action. If he exhibits an inclination to learn, is industrious, and becomes thoroughly interested in his efforts to become familiar with the foundry practice, he should be assigned some slight duty that would make him profitable. At the end of the probationary period, make a contract with him for three years and nine months, giving him the benefit of the three months as a novice. If at the end of three months' probation he does not seem inclined nor interested, it would be a kindness to the boy to request him to try something else.

I do not believe that moulders are born, not made, but I will say that unless you have the material in the individual to make a moulder, you can not possibly accomplish anything. After he has been accepted and regularly indentured, then it becomes very much the duty of the foreman to see that he will become a competent man and a good mechanic.

The boy starting in on his first piece feels a certain amount of excitement and interest which should be cultivated and kept alive. He should not be scolded, cowed or bully-ragged for a slight mistake, but should be encouraged by a few kindly spoken words, as there never was a brow-beaten and cowardly apprentice who made a successful or first-class moulder. It is by implanting the spirit of "I can" and "I will" in the heart of an apprentice that you obtain the best results. What I mean by a cowardly apprentice is not the boy who will be afraid to knock his shop-mate down for an insult, nor to be afraid to resent harsh words, or ill treatment, but the one who is afraid of losing the casting he undertakes to make. I believe there are more castings lost through an over anxiety to make the work correct than from carelessness or any other cause. Every shop should have one or more first-class journeymen whom the apprentice should be encouraged to take as his model, so far as possible. Yet it is necessary to encourage originality after a certain period. The

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apprentice should be encouraged to be self-reliant, and be advanced as he succeeds in making good and satisfactory work. The older moulders should not be allowed to stand in the way of advancing the apprentice on to the very best work in the shop, if he proves himself able to turn it out satisfactorily.

The apprentice should further be encouraged to interest himself in all the details of the foundry practice, the character of the sand best suited for the different classes of work, and also the different brands of iron that go into the mixtures for different grades of castings. In fact he should be taught that the mixing of the metal and cupola practice is second only to the making of the mould itself. The character of the coke, the height of the melting point in the cupola, the regulation of the blast, the temperature at which the iron is melted, and the grading by fracture and other methods; all these he must be shown to have the greatest bearing on the finished casting.

The time spent in the education of the moulder's apprentice in all points of foundry practice pertaining directly to the making of the casting, is one of the best investments any foundry manager can make, for it is the apprentice, well educated in these matters, who makes the first-class moulder.

We might go more into detail by giving instructions as far as possible to the apprentice, covering each detail of the work, but this would be impossible in a paper of this kind. If the management of all foundries would seriously consider the subject of the education of the apprentice and adopt some universal system of educating apprentices, it would tend greatly to solve "The Problem of the Moulder."

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GREEN SAND CORES.

By MR. P. R. RAMP, Aurora, Ill.

This subject bears directly on the foundry business and is one of the important features in moulding. A green sand core is a core constructed from the same material used to make a green sand mould. It is not dried in an oven but placed in the mould as soon as completed, thereby saving the fuel that is necessary to fire the core oven when dry sand cores are used. In making light castings the green sand core has an advantage over any other core because it overcomes the rough and irregular joints that are often found where a dried core and a portion of the mould come in contact with each other. In cases where a large core is nearly completely surrounded by a thin casting the green core is the best also. If a dried core is used there is always a liability of the heat from the casting causing the material in the dried core to expand and thus break the casting. Another advantage is when cleaning castings a very large dry sand core requires considerable time and labor to dig out of the casting; if a green sand core is used all that is required is to rap the casting in order to remove the sand.

Green sand cores can be used to advantage in the production of plumbers ware, i. e., soil pipe, elbows, tees, etc. Also locomotive smoke stacks, railroad oil boxes, and similar castings. These cores cannot be made strong enough to be handled without some kind of a support. An arbor usually made of cast iron, often of wood, is used to carry them.

In making a green sand core for a locomotive smoke stack the proper rig would be a cast iron core barrel 1 inch thick, the shape of the cored portion of the stack, allowing only about 1 inch for sand between the barrel and the inside of the stack. The barrel must be cored with prickers about 1½ inches long by ½ inch in diameter, tapering to a point, in order to carry the sand. There should be equally as many ½ inch holes in the barrel to allow the gas to escape freely. Both ends of the barrel should be turned off to suit the ends of the flask the mold is made in. The core is

formed by setting the barrel on two wooden horses with iron bearings attached to them for the spindle of the barrel to rest in. The sand is now pressed between the prickers and a strike of the proper shape is placed on the wooden horses the right distance from the barrel, a crank is used to turn the barrel as fast as the sand is pressed between the prickers. In this manner a stack of any thickness may be made from one core-barrel. As soon as the mould is poured and the casting is cool enough a chain is hooked on to the end of the barrel and the barrel and casting are hoisted to a vertical position. A little rapping on the casting will cause the sand between the core-barrel and the casting to run out and relieve the stack which will drop off of the barrel. In this case a dried core would make a very poor job. Not only would it cost more to make the core and furnish the material, but, as stated before, the expansion of the material would break the casting because the generally averages about 3-16 inch thick.

Core barrels for soil pipe cores are made on the same principle instead of prickers, however depressions are made in the barrel. Where it is not possible to use a core barrel arbor and anchor, lifting plates are used. Often the arbor must be made in sections to enable the moulder to get it out of the casting after the mould is poured. Lifting plates are generally made with threads for lifting screws to make it possible to take the screws out after the green sand core is placed in its position in the mould. There is considerable core sand and labor saved in making railroad oil boxes with a green sand core. In this case an arbor made in sections is used, the shape and number of sections depending entirely on the size and shape of the oil box.

There are many small dry sand cores (such as cores forming round and square holes of different sizes) used that could be made in green sand much cheaper. One of the reasons they are not made in green sand is because the pattern maker, as a rule, carries a stock of core prints of different sized round and square cores. He knowing there are core boxes for the different sized cores in the foundry, finds it much less trouble to tack on several small ready-made prints than to finish out several holes the same size so they will leave the sand properly. As a result the foundry foreman is disgusted to find that he is compelled to make a lot of small dry sand cores, say 1 inch by 1½ inches, that could just as well be made in green sand. There is, without a

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doubt, quite a sum of money spent every year for labor and material to make dry sand cores that could just as well be saved or put to some better use. So it is with the dry sand cores we often find foundrymen worrying along with a job trying to use green sand cores where a dry sand would be the cheaper. To be able to judge which of the two kinds of cores is the better and cheaper to use in making any certain job, we must have practical experience in the business. For instance, in case of the smoke stack a dry sand core would not be practical, neither would a green sand core for the steam ports or bore of a Corliss cylinder be a success.

Green sand cores are not good for making bulky castings where there is a heavy pressure of metal. One reason is because it is not possible to make a green sand core hard enough to withstand as great a pressure as a dry sand core will stand without a cut or scab. Another point in favor of the dry sand core is when it is placed in the mould, say an oil box, if it does not give the proper metal on all sides by reason of it not being placed in properly, it can be taken out and reset, whereas, in case of the green sand core it is very risky business to remove it after it has been placed in the mould.

So I say in conclusion that in making light castings there are many cases where the green sand core can be used to a decided advantage. On the other hand there are cases where the dry sand core is the better. I am a little inclined to favor the dry sand core except in cases as mentioned above. Because I think the dried core is the safest and in making castings of any great size that must free from dirt, etc. I have always found it cheaper to make a dry sand mould. Many foundries do not favor dry sand cores. Often it is because the core sand they are useing is not what it should be. In making cores for locomotive and Corliss engine castings I use for my core sand mixture about 6 parts heavy molding sand and 4 parts sharp building sand. If my castings do not clean very well or show dirt I add a little more sharp sand. Many foundry men worry about the blacking. My experience has been, if I used a good open sand and have vented the core of mold well, and had it thoroughly dry, a fair grade of blacking always did the work as well a more expensive grade.

The foundry supply men often speak of the different foun-

dries that use their blacking. I always think, "Well, no matter how good the blacking if there is not a good open sand behind it."

We often find cases where the blacking on the dry sand mold or core has washed off in flakes before the iron while it was being cast. One of the old established remedies for this trouble is molasses-water. This does some good, but I feel satisfied that a little more coarse sand in the mixture would be of more benefit.

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VOL. X. JUNE, 1901. PART I.

CONTROL OF THE FOUNDRY.

By MR. PERRY LONGMUIR, Sheffield, England.

The question of foundry management and control was discussed before this association last year and has been debated at more or less length in various technical journals. It will only be necessary, therefore, to give a few thoughts under this heading and these only so far as they affect the ultimate relationship of Laboratory and Foundry.

The generally accepted method of control by a foreman trained only as a moulder and who has possibly gleaned a few hints on the mixing and melting of iron, leaves much to be desired. Even though this plan may operate with more or less apparent success in a speciality foundry where one class of work only is done, and consequently a standard mixture in use. The success attained is in many cases only superficial and examination will reveal that little advance is made in such an establishment. No foundry can afford to be stationary for this condition ultimately results in stagnation, and eventual decay. Any method that will put a spoke in the wheel of progress demands attention, and if the methods of foundry management will admit of improvement, any or all schemes tending to that end are well worthy of consideration.

The most evident need in the general run of foundries is that they be operated on more intelligent and methodical lines. Systematic must replace haphazard methods in both moulding and melting, and the many special fluxes and nostrums so familiarly known as "warranted to remove all the imperfections of the iron" must be replaced by scientific and exact methods of mixing and melting.

In order to secure better conditions dual control has been proposed—that is to say management by foreman moulder and chemist. The writer has for some time contested this proposition, for on the face of it no foundry can operate successfully under divided management. Of necessity there must be one head and he alone held responsible for results. With divided respon-

sibility the difficulties of a work director, particularly if he has no knowledge of foundry matters, are considerably increased, unless the foreman and chemist work harmoniously and that cannot always be guaranteed, he will have no little trouble in fixing responsibility for bad results.

Granting that divided responsibilities will not meet the advancing requirements of our foundries, in what other direction can we turn for a solution of this problem? The present style of a foreman trained as a moulder only will not always prove effective, and on the other hand an analytical chemist is by the very nature of his training unfitted to take the full management of a foundry. If the chemist is in possession of a sound knowledge of the three branches of moulding and has had a training in general foundry work, that of course alters the completion of things.

A foundry manager must have a thorough and complete knowledge of the various methods of moulding and be well versed in the necessary metallurgy. Herein lies, to the writer's mind, the true solution of the foundry management question.

Let the foreman moulder be given a scientific and metallurgical education, or on the other hand give the chemist a thorough training in the principles of moulding in green, dry sand and loam.

Taking it for granted that the chemist is able to obtain such a training, it will be asked how is the moulder to obtain his special knowledge of scientific founding and metallurgy. In the November "Foundry" the writer advocated the following plan:

Foundry foremen of this age to be really successful must be specially trained for the work. This training must comprise a thorough knowledge of practical work, that is the making of moulds by the best methods in green and dry sand or loam and also the devising of special tackle for the quick production of such moulds. It must include a knowledge of metallurgy as far as it affects the metals they handle and a knowledge of the laws governing the crystallization and contraction of metals. An up-to-date foundry manager must be able to read intelligently a mechanical drawing, be able to get at his working expenses accurately, and, above all, be able to handle men efficiently. A training of this kind will not be gained without considerable trouble and much personal discomfort. Any moulder wishing to become a foundry manager must, in the first place, pay special

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attention to the moulding and make his knowledge as comprehensive as possible by gaining experience under as many differing conditions as practicable. Whilst doing this the greater portion of his evenings must be spent in study—real hard study starting with a couple of years in mathematics and machine drawing. A session devoted to elementary inorganic chemistry could follow this and the following three years devoted to the study of theoretical and practical metallurgy which for convenience may be divided into two sections.

1. Iron and steel metallurgy.
2. Metallurgy of copper and its alloys.

The section most likely to meet individual requirements should be taken and the autumn and winter evenings for a term of three years devoted to a hard and close study of this subject. The practical side should include chemical, mechanical, and microscopical analysis and mixing and melting from the results of such analysis. The course should also touch upon furnace design and construction, fuel and refractory materials, etc. A training such as this will fit a moulder to act efficiently as foundry manager, and other things being equal, with good hope of obtaining a fair share of success. He would be equally at home on the moulding floor or on the charging stage, and he would be in a condition to properly appreciate the work of the chemist. Irons would be mixed on the analyses supplied by the latter, whose duties, under these conditions, would seldom take him from the precincts of his laboratory.

The writer would not for on moment limit the sphere of the chemist, but his experience has proved that divided responsibility ends in disaster whether that division be between foreman and chemist, or between foreman and any outside individual, as for instance a work manager unacquainted with foundry matters. The very nature of foundry work necessitates one head—it need hardly be said that that head must be a thorough master of his business, and therefore it behooves practical foundrymen to acquire the necessary scientific knowledge in order to appreciate and utilize the work of the metallurgist.

If the foundry chemist has free time it should be devoted to experiment and research conducted with the co-operation of the manager, and there is no foundry in existence which can af-

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ford to neglect experimental work. Not a few foundries do a large amount of it unconsciously, as their scrap heaps testify. This, of course, is no new feature; it is simply one of the many aspects in which the foundry laboratory may be regarded. The opportunities for profitable experimental research are great in an iron foundry. They are still greater in malleable, brass and steel foundries. This matter is simply mentioned in order to show what, to the writer's mind, are the most profitable and promising fields for the employment of a chemist apart from his routine work. The full control of the foundry must be left in the hands of the foundryman, who possessing a knowledge of metallurgy and the advantages of a thoroughly practical training is enabled to mix his metals from the laboratory results, and, at the same time, to put into practice the results of the experiments supplied by the chemist.

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INFLUENCE OF TITANIUM ON THE PROPERTIES OF CAST IRON.

By MR. AUGUSTE G. ROSSI, New York.

Titanium is a very common constituent of iron ores. When below 1 per cent. it is usually ignored. When, however, the titanium oxide runs from 10 to 40 per cent. or over, the ores may be legitimately called "titaniferous" iron ores, and these occur in mountain masses in several states. Usually free from sulphur, and particularly phosphorus, and low in silicon, they form excellent stock to mix with soft ores. Titaniferous ores have been smelted successfully in this country and Europe, and enormous masses still await utilization in Sweden, Norway, Canada and the United States, and this is especially interesting to foundrymen, as the pig iron made from these ores has always been considered of special value.

In 1894 Mr. Jeremiah Head read a paper before the Iron and Steel Institute, in which several references are cited. Prof. Deelrick, of Aix la Chapelle, regards the value of titanium a good subject for study, as it seems to "communicate to the iron an unusual degree of toughness." Mr. Riley found the pig iron "everything that could be desired." Bauerman, finally, in his work on metallurgy, finds that the presence of titanium in pig iron "increases its strength."

We therefore have positive statements on the influence of titanium on cast iron which show that it is favorable, be the action itself a direct one by alloying, or indirect by the removal of deleterious influences. My own experience in producing several hundred tons of pig iron of this nature from ores running 14 per cent. titanic acid, 59 per cent. metallic iron, 1.5 silicon, .017 phosphorus, and .025 sulphur, may be of interest as bearing directly upon our subject.

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The analysis of this pig iron is as follows:

Silicon	0.12	0.174	0.36	0.17
Manganese	0.08	0.232	0.07	0.25
Titanium	0.07	0.183	0.24	0.05
Combined carbon	1.35	3.070	2.95	3.09
Graphite	0.14	0.327	0.24	0.255
Phosphorus	traces	0.024	traces	0.93
Sulphur	0.059	.....	0.045	0.022

This iron, an ideal stock for open hearth, was very strong; it could almost be forged cold and proved very valuable in car wheel mixtures. Added to foundry iron it increased the tensile strength considerably and is said to have retarded the solidification of the metal in the molds materially. Twenty-five per cent. to 30 per cent. of this iron in admixture with others cast in chills could not be touched by chrome steel drills, and reamers for the hubs of car wheels made of this mixture, and subjected to the most trying conditions were found in good order after one year's service. Test bars with 25 per cent. of this titanic pig iron 1 inch by 1 inch by 12 inches between supports broke at 3,480 pounds, and cast on 1½ inch by 1½ inch by 2 inches chill blocks gave a chill 1.62 inches deep. The original metal had a transverse strength of 3,390 pounds and chilled 1.06 inches. The addition of 5 per cent. of the pig similarly gave 3,778 pounds and a chill of 1.37 inches, while the pig itself gave 2,750 pounds and was chilled throughout. We have, therefore, a corroboration of the statement made by the eminent metallurgists before mentioned which should be of value to us.

Titanic acid is not reduced directly by carbon at the temperatures prevailing in the blast furnaces, and the small percentages we find in pig irons are the result of other combined influences. The use of such pig irons in quantity in our mixtures does not, therefore, introduce anything but traces of titanium into the castings, but a beneficial result is nevertheless obtained. The properties of the titanic pig suggest its use for crushers and machinery in which substances of great hardness are to be pulverized. Manganese steel, while tough, flows too easily, and whenever it has yielded under strain it sets. By the judicious use of 10 to 20 per cent. or more titanium alloys a material of sufficient hardness and strength might be produced which would

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withstand the severe usage this class of machinery is subjected to.

The demands of civilization have materially developed the steel industry and reduced its cost. Unless, therefore, a greater strength is obtained from cast iron than is now the case steel may prove a winning competitor. Specifications for cast iron are becoming more and more exacting, and can only be met by a careful selection of the material offered. High grade irons must be used and necessarily a high price paid therefor. Now, if titanium proves to be a saving factor as it evidently appears, we cannot bestow too much attention on this new claimant for our favor. That the greater demands for hardness can be satisfied has been proven repeatedly, and it will be shown presently that the tensile strength can also be increased considerably.

A few words on the preparation of titanium alloys would not be amiss at this juncture. (The full classification of the manufacture and results obtained may be found in Mineral Industry, Vol. IX.) An electric furnace is used. It consists essentially of a block of graphite having in the center a rectangular cavity for the reception of a layer of scrap iron, and powdered ore and charcoal well mixed on top of this. The block is connected with one current terminal. A movable carbon electrode placed in the centre and connected with the other current terminal allows the formation of the arc necessary to obtain the proper heat for the reductions. This makes an alloy of titanium and iron containing 5 to 7 or more per cent. of carbon. The proportion of the charge will naturally vary with the percentage of titanium the alloy is to contain. One of the ores smelted, from the Adirondacks, contained 9 per cent., another from Canada 24 per cent. titanium.

Where an alloy free from carbon is wanted aluminum is used in place of charcoal as the reducing agent of the metallic oxides. Scrap aluminum is used and a bath formed in which the ore is reduced, the oxidized aluminum uniting with the gangue to form a slag rich in alumina and harder than natural corundum, which it equals as an abrasive. When an ore was mixed with enough carbon to reduce only the iron, but not the titanium present, lime being added, and a very weak current used, the temperature prevailing was insufficient to reduce the titanic oxide, and a charcoal pig iron with but traces of titanium was obtained. The concentrate remaining contained all the titanic ox-

ide of the ore, combined with lime and other bases, and when properly powdered and mixed with carbon or aluminum could be reduced in the usual way. The result was an alloy practically free from iron which could be made to run up in titanium almost to 100 per cent. The pig iron made during the preparation of the "concentrate" is really a by-product, but is nevertheless an important factor in reducing the cost of the alloy produced. The alloy free from iron thus obtained should form a very valuable ingredient in mixtures other than cast iron and is commended to the attention of our founders of bronze. The ore used for this process contained 1.5 to 2 per cent. silicon, 14.5 per cent. titanic acid, 80 per cent. oxide of iron, a little lime, alumina and magnesia, with phosphorus .017, sulphur .024. The pig iron obtained contained only .04 per cent. titanium, while the "concentrate," after treatment, gave an alloy containing .83 to 1.00 per cent. silicon, 7.28 per cent. total carbon, sulphur .011 and phosphorus .064. This pig iron was exceedingly strong, breaking with difficulty and behaving w[illegible]nder cold forging tests.

Titanium alloys are light, becoming more so as the percentage of titanium rises, the specific gravity of this element being only about 5. The melting point also goes up as the titanium contents rises. The tests so far made have all been by additions to the iron while in the ladle or in crucibles. No [illegible]charging in the cupola has so far been attempted. Test b[illegible]ere always made, giving the iron before and after the addi[illegible]s, so that a fair comparison would be possible. It is necessary to break the alloy into small pieces in order to get a complete incorporation with the iron in the ladles, and if preheated the results will be even better. In crucible work it can naturally be added in any shape desired, as the whole charge is made up before melting.

The general conclusions derived are that a 4 per cent. addition of a 10 to 12 per cent. titanium alloy is most effective for the improvement of the castings made. It is also confidently believed that the alloy can be made cheap enough to allow a 4 per cent. addition to be made without affecting the cost of the castings seriously, for the benefits derived are such that expensive irons can easily be cut out or at least reduced to smaller amounts in a given mixture.

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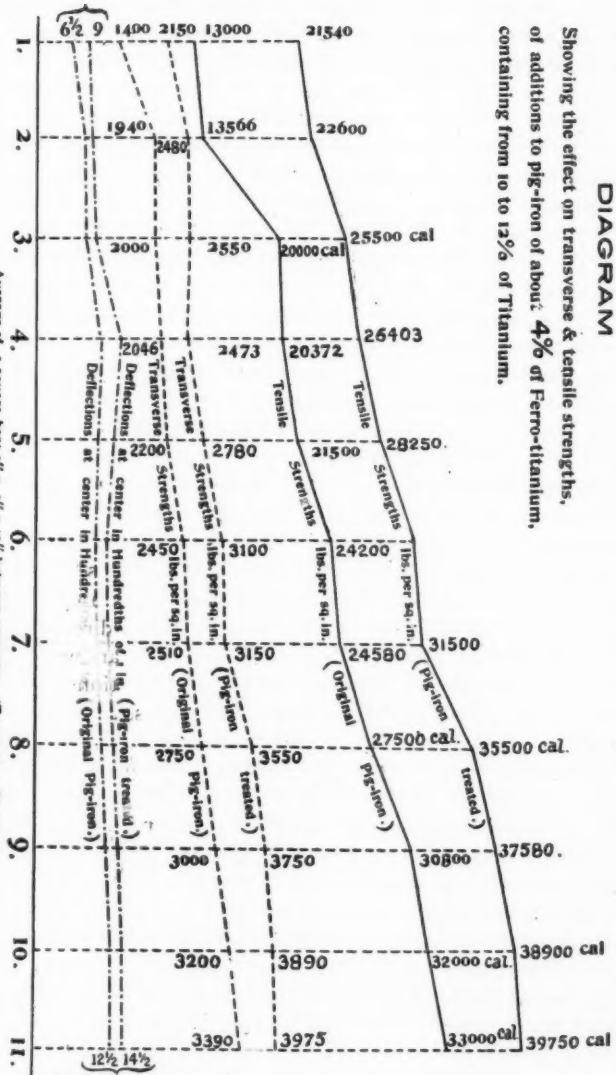
DIAGRAM

Showing the effect on transverse & tensile strengths, of additions to pig-iron of about 4% of Ferro-titanium, containing from 10 to 12% of Titanium.



Average of 3 square bars 1" x 1" x 12" between supports. (Transverse Strength.)

Average of 3 round bars 0.73" diameter x 18" long. (Tensile Strength.)

As will be seen from the diagram the tensile strength of irons running from 11,000 to 15,000 pounds per square inch was raised to 20,000, and good irons with 20,000 to 25,000 pounds rose up to 28,000 and 35,000 pounds, and more after the titanium additions. The deflections also follow closely, and the parallelism of the curves shows that the improvement is not a casual one only. A series of tests were made recently to determine the value of additions of 1, 2, 3 and 4 per cent. of the 10 per cent. alloy respectively, the results of which follow later.

While the tables seem to show that the action of titanium, so far as the improvement of the castings is concerned, is a direct one, yet there may be some indirect effects involved. For instance, there may be occluded gases, such as nitrogen or oxides and nitrides of iron, which prevent the intimate contact of the crystals so necessary for strength removed. This action of titanium has been long suspected, in fact was pointed out by Mr. Wm. Metcalf as the metal titanium not only unites readily with nitrogen, but actually burns in it. In any case the analyses before and after using show practically the same composition so far as silicon, the carbons and other constituents are concerned, except for the titanium found in the pig iron originally. This would show the value of titanium on the admittedly poor irons and open a field for them which would dispose of much stock now sacrified.

The question of expense is really not so serious as it looks, for the improvement effected justifies an extra outlay. Thus chromium costs about $1.00 a pound, nickel 35c, tungsten 90c, and even $2.00 a pound is paid for molybdum. Yet all these metals are used extensively in steel making and in percentages ranging from 3 to 10 per cent. to be of use.

The same remarks hold good for cast iron. For steam and water pipes, gate and steam valves, steam fittings in general, working under the great pressures now required for large steam cylinders, fly wheels and many purposes of foundry where a greater tensile strength is a desideratum, these alloys could find an excellent application.

Car wheel materials have special requirements to fulfill which necessitate a careful choice of the materials entering in the mixture. If, by the addition of the alloy, the use of cheaper materials becomes admissible even thus realizing superior results to those now obtained, such addition not only may not increase the

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first cost, but actually lower it. Certain railroads which require the "thermal test" are even willing to pay extra for the best results. In this particular line there is a still more important consideration. It appears that, with the new pressed steel cars, which have a capacity of 100,000 pounds, as against some 50,000 pounds, as formerly, the pressure on the wheels becomes so great that the tire "actually disintegrates under the strain and that wheels guaranteed to furnish a 5 years' service and excellent otherwise, will not stand a run of 10,000 miles, or less than one year service. The demand for a stronger material is imperative here, and the question of cost has lost much of its importance. Would not this case (which is only one example amongst many other applications of the same kind which could be given) show that the use of titanium which secures a considerably increased tensile strength in the body of the wheel and a greater strength and hardness of chill on the tire can be particularly well adapted, even were it to cause a slight extra expense.

We have already mentioned the possible applications of the alloy for mixtures for crushers of all kinds. Assuming the increase in tensile and transverse strength to be as observed in the experiments recorded or 25 to 30 per cent., does not such an improvement admit of the possibility of diminishing the thickness and weight of castings which are not necessarily required to stand special or severe strains. Cannot this saving of materials offset the entire expense resulting from the alloy, small as it would be in any case, for ordinary foundry purposes.

At one of the greatest construction works of the country large cylinders which are poured very hot show iron with a low tensile strength even if the silicon and phosphorus are kept quite low. Were the titanium alloy added here the extra heat would only result in an advantage, for the hotter the more complete the incorporation. In another foundry it was observed that the solidification of the metal in the moulds was retarded considerably, and this may be explained by the very high specific heat of the alloy used. Here, then, is another advantage especially for roll makers who wish to keep on feeding into the head a long time.

Titanic acid a mineral (Rutile), while found in many localities is not so abundant. It is usually associated with 5 to 10 per cent. of iron oxide. When less than 5 per cent. of iron oxide is

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present it is worth $450 a ton. Between 5 and 10 per cent. the value dropped to $350 or $300 a ton, and ordinary titaniferous iron ores are at least as cheap as ordinary iron ores, if not cheaper. Now that a good "concentrate" has been obtained from these cheap titaniferous ores, and the same operation also gives a good charcoal iron which helps to reduce the expense, there should be no reason why the alloys of titanium and iron for foundry purposes should not be bought quite reasonably.

This "concentrate" above mentioned has been used to make alloys of titanium and copper containing from 8 to 15 per cent. titanium. These alloys, added in the proportion of about 4 per cent. to manganese bronze have given the following results: On round bars, diam. 0.798 inch; area, 0.500 square inches.

Tensile strength .....63,080 lbs.
Limit of elasticity 25,200
Elongation 45%
Reduction of area 41.56%

These results were considered important enough to be repeated with different percentages of alloys and manganese bronze containing less copper than the bars tested. The copper titanium alloys, when high in titanium, 10 per cent. and over, scratch glass, below 10 per cent. at about 2½ to 5 per cent., their color is very much like that of gold, as specimens exhibited show, and they are still quite hard.

I have mentioned these experiments, though they are far from being complete, yet as they justify serious investigations on the part of foundry men who more or less have brass castings to make. The cost of these copper titanium alloys is, of course, higher than that of ferro-titanium, owing to the percentage of copper they contain, but their manufacture is easier even than that of the ferro-metal, and on this score they could be made cheaper comparatively speaking . By smelting together, in a crucible, titaniferous and phosphoric ores, the mixture having been made purposely high in phosphorus, a phosphoric pig containing as much as 3.225 phosphorus and 0.47 titanium which had all the quality and strength of a No. 1 foundry pig, was obtained. The same results would be likely to be secured, to judge from preceding experiments, by adding in certain proportions the titanium alloys directly to a phosphoric pig which the amount of phosphorus

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present would render unsuitable for many purposes of the foundry.

I give below the analyses of the pig metal obtained in these experiments as they seem to show the action of titanium in presence of large amounts of phosphorus.

In these experiments the same highly phosphoric mixture was used as a basis, and to it was added the titanic core practically free from phosphorus, plus a certain amount of apatite to equalize as much as possible the percentage of phosphorus in the product.

(A) Phosphoric Pig from Phosphoric Normal Mixtures.

Graphitic Carbon	2.98
Combined "	0.18
Total	3.17
Phosphorous	1.125
Titanium	0

No. 2 light.

(B) Phosphoric Pig from Normal Mixture. + 25 % Titanic Ore.

Graphitic Carbon	3 54
Combined "	0.33
Total	3.87
Phosphorus	1.229
Titanium	0.35

No. 2. gray.

(C) Phosphoric Pig from Mixture made highly Phosphoric.

Graphitic Carbon	2.407
Combined "	1.245
Total	3.652
Phosphorus	2.862
Titanium	0

No. 2 light, weak.

(D) Phosphoric Pig from same Mixture as C + 35% Titanic Ores.

Graphitic Carbon	3 98
Combined "	0 11
Total	4.09
Phosphorus	3.229
Titanium	0.47

No. 1 Foundry Strong.

The two crucibles containing the mixtures A and B under the second experiment the mixtures C and D were placed in the same fire, side by side, and fired for the same time. The amount of titanium was small, but important in both cases D, B because the titanic oxide of the titaniferous ores is not reduced directly by carbon at such temperatures as are available in a blast furnace or even a steel furnace, but in these experiments special influences caused the titanium to pass to that extent in the pig metal. The quantities of titanium found in the pig iron, if to them is to be attributed the results observed, could readily be supplied by additions to the phosphoric pig of 4 to 5 per cent. A ferro-titanium containing 10 to 12 per cent. titanium like the one used in the cast iron tests.

APPENDIX A.

At the request of the Secretary of your Association and through the courtesy of the Abendroth & Root Mfg. Co., I was enabled to make a set of tests to show the effect of adding various quantities of ferro-titanium to ordinary foundry mixtures. The work was carried on impartially and the results herewith may be relied upon as accurate.

A.—Bars Cast Horizontally.

	Transverse Strength.	Increase.	Tensile Strength.	Increase.
Original mixture..	2,030 lbs.	.....	20,500 lbs.	.....
1 % addition of alloy.....	2,100 "	3.5 per cent.	22,200 "	8. per cent.
2 " " " ...	2,200 "	8. "	24,600 "	20. "
3 " " "	2,300 "	13. "	26,000 "	26.9 "
4 " " "	2,550 "	25. "	25,900 "	26.4 "

B.—Bars Cast Vertically. (Another series of tests.)

	Transverse Strength.	Tensile Strength.
Original mixture	1,393 lbs.	16,600 lbs.
1 % addition of alloy	2,410 "	18,100 "
2 " " "	2,000 "	19,500 "
3 " " "	2,300 "	20,600 "
4 " " "	2,360 "	20,000 "

It will be seen that the effect of 3 to 4 per cent. is not marked and adds one-fifth of lead to the strength of the material.

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THE ECONOMIC STATUS OF WAGES.

By EDWARD HOWELL PUTNAM.

Under normal industrial conditions, wages constitute the chief item of manufacturing expense. That is to say, the larger part of the selling price of product represents the cost of labor, of hand or brain.

One of the most vexatious annoyances of both the teacher and the student of political economy is the extreme difficulty of defining the term, labor, so that all shall understand just what is meant by it. To most people it merely signifies manual labor, and the wages-receiving class is suggested as the sole performer.

No greater mistake would be possible. The productive power of a single thought, flashed from the brain of genius, may outmeasure the life's labor of a thousand pairs of hands.

Every man who devotes his energies, of either hand or brain, to useful exertion anywhere in the field of industry, is a laborer.

The higher the quality of labor, the greater should be the compensation, or wages. This principle is generally recognized in practice, and none but socialists deny its justice. And I have not heard of an instance of socialistic mechanics having suggested a diminution of the wage-rate of their class, in order to advance the wages of those beneath them in point of quality. When the foremost exponent of the principle of equality will immolate the most sacred institution of time, or eternity, upon the altar of selfishness, he conclusively demonstrates the general impracticability of his doctrine.

To deny that the higher quality of labor is justly entitled to the higher wages, is repugnant to common sense, and contemplates the impossible in practice. The higher the quality of labor, the more it will produce within a given time. For instance, a first-class mechanic, who has given his mind to the earnest study of his trade throughout a long period of years, can produce

more of value in a day's work than the common laborer, whose lack of ambition has prevented that mental training which alone can lead to high achievement. Shall we pay them both alike? Not while sense, instead of sentiment, rules the world. In short, we are not yet ready to begin to pay men for being, and shall insist that just wages is the equitable reward of doing.

The present age is pre-eminently the most wonderful period of the world's history. In past ages, the world-activities of any one year were so like those of preceding years as to be hardly more than a slightly expanded repetition. To-day, each succeeding year unfolds a new world, with multitudious features, new and marvelous. The progeny of the Lame Lemnian, no longer content with waking the echoes of the Olympian forge, have scattered abroad, and the ceaseless clamor of their anvils rings the chorus of industry around the world!

The foundry, that, but a few years ago was an isolated local institution, of uncertain and intermittent activity, depending upon a small neighborhood area as an absorbent of its crude products, to-day is become part of a worldwide industry, closely interrelated in all its branches, each of which is hopelessly subject to the inexorable law of Competition.

In former times, if local wages were comparatively high, the price of castings could be made to correspond. To-day, with one common market, which, like the waters of the sea, tends always to a common level, practical uniformity in cost of the various factors of the product is of vital importance.

Wages is an element of cost which ought to be so adjusted as to afford all employers an equal chance in the field of competition.

The employer who, other things being equal, pays a much lower rate of wages than his competitors in general, is the enemy not only of his own workmen and community, but he is a menace to his competitors in business.

Unequal wages make unequal profits; unequal wages produce conditions under which one concern may be forced into bankruptcy, while another may prosper.

Under the prevailing industrial system, the question is not: "What wages shall I pay?" but, "How does the wages that I pay compare with the rate paid by my competitors?"

Every business man is entitled to all the profit that his busi-

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ness ability shall enable him to produce. If you pay higher wages than your competitors, other things being equal, then, either you are paying out in surplus wages something that ought to inure to yourself, as profit, or, your competitor is appropriating to himself, as profit, something that ought to be distributed among his workmen as wages.

I assume that the saying: "A fair day's pay for a fair day's work" means something among business men. It is not a cant word, thrown out upon the industrial throng for the purpose of blinding somebody to an ulterior, hidden purpose. It is the ingenuous statement of an honorable, righteous principle. Thus, if A pay a fair day's wages for a fair day's work, and B pay less wages for the same amount of work, then B is not paying fair wages. Again, if a mechanic, C, is doing a fair day's work for a fair day's pay, and D, another mechanic, does less work for the same pay, then D is not doing a fair day's work.

But, what is a fair day's work? We have not time to answer the question minutely; but, broadly speaking, when a man has worked hard and faithfully for a period of ten hours, applying his mind to the task in hand, with the honest purpose of turning out an abundant and excellent product, that man has done a fair day's work.

And what is a fair day's pay? It is, briefly, the equivalent in value of a fair day's work. It is the prevailing wages in any section of the country.

The National Founder's Association has taken a long step in the right direction toward a solution of this problem. This society, in conjunction with the moulders' union, seeks to equalize work and wages in the several districts, agreeing to a certain rate of wages for each district, and to the principle that the work performed for the day's wages should be as nearly uniform in amount as possible.

Though perfection in a matter of this character is unattainable, yet far better results must ensue from concerted endeavor than could be expected under the preceding disorganized state of the foundry trade.

The expression, "a day's work," must not be confounded with the idea of a day's product. The former, meaning the energy expended by the workman, may remain nearly constant, while the latter must expand, with the advance in economic

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methods and machinery. This element of increase in the output per man is one that neither intelligent purpose nor stupid prejudice can successfully combat. Banish this feature from the industrial prospect, and no man of understanding could contemplate the future of the race but with a feeling of despair. To say that the limit of product per unit of human force has been attained, is to surrender all hope of material progress.

The productive power of society is to-day ten times what it was fifty years ago, and who shall say that it shall not be twenty times greater fifty years hence than now?

That man or institution which shall stand in the way of this natural unfoldment of human capacity will be crushed by the onward sweep of social progress!

Now, with all our splendid achievements in perfecting methods and machinery whereby productive power has been many times multiplied, yet something is wanting in the industrial equation. We cannot sell all that we can produce. We have given our minds to the invention of superior facilities of production, to the almost total exclusion of the science of distribution. Observe, I do not refer to the arts of distribution; these have kept pace with our productive capacities. But, that branch of political economy which treats of capital and labor—profit and wages—stops where Malthus left it, a hundred years ago.

The taint of Malthusian poison in the veins of the industrial body is too apparent to be ignored. It is manifest in the disposition of the trade unions to combat the labor-saving machine, the world over; and, in England, it displays an alarming virulence, in the shape of pressure upon the shop foreman to employ additional men without increasing the output!

We cannot, however, eradicate the poison of false economic teaching by simply denying its truth.

If Malthus was right, then the labor unions are right. If, as Malthus assumed, population increases faster than the means of subsistence, then, the distribution of the work to be done among as many individuals as possible is plainly an effort toward self-preservation.

If, on the contrary, the doctrine is false, then it is incumbent upon the objector to set up a true doctrine in its stead, and that true doctrine must, in practice, eradicate the evils which the false doctrine assumes as inevitable.

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In other words, if we would discredit the reactionary methods of the trades unions, we must do it by removing the causes which impel them.

The man who invents a valuable labor-saving machine can make one, set it in operation, and, whether society will or no, give to society the benefit of his inventive genius. That is progress in the art of production.

But he who, by patient study and deep excogitation, through years of mental labor, discovers hitherto unknown correlations of natural law which, in pratical operation, would enrich the world "beyond the dreams of avarice," stands a pitiful object of impotency in the chaos of social life; buffeted on every side by conflicting individual interests, prejudice, ignorance, fear, envy, indifference!

That is scientific stagnation.

Individual interest makes easy progress in the arts of production. There's money in it—sure and quick returns. On the other hand, general ignorance of economic law, and the necessity for public co-operation in its successful employment, makes progress in the science of distribution slow—painfully slow.

No wonder, under the circumstances, that the science of distribution fails to keep pace with the arts of production. Nevertheless, these two corresponding industrial factors must balance or derangement and stagnation will certainly follow.

I have no labor-saving machine to offer you at this time, but, on the other hand, I would present for your consideration a statement of the true correlations of certain natural laws which, applied in the industrial realm, would remedy the factor of distribution, by causing an unfailing demand for the fruits of all the productive forces of society, employing every man, and, to the full, every labor-saving device that now is, or that ever shall be invented.

In the light of all past industrial history, this will appear, to say the least, an extravagant assertion. And yet, reduced to the simplest terms, it is merely saying, in effect, that all men may work as hard as they please, and that they may have and enjoy the full product of their labor.

This simple form of statement, presents the fact to the mind as an absolute truism.

If the primitive society of the backwoods find no lack of em-

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ployment or glut of commodities, why should the centers of advanced civilization encounter such obstacles?

There is no necessary reason for it. A perfect knowledge of the natural laws of distribution would entirely remove these obstacles.

The element of exchange in the industrial mechanism is where the trail of sequence in economic law is covered from the general view.

Both the old-school political economist, and the socialist stumble here. The former assuming that, since nominal prices, profits and wages are merely relative terms, the world is quite as well off on a low price scale as on a high one. The socialist, however, thinks he sees in a low wage scale, a high margin of profit, and believes that any increase in wages must come principally through reduction of the rate of profit.

They are both wrong.

You will seldom find an employer of labor (that is, a capitalist) who is a socialist. Socialists are, largely, wage-workers, literary men and women, and theologians.

The wage-worker is apt to favor socialism, because he thinks he sees in it a probable distribution of the accumulated wealth of the world among the poor, to begin with, and better things to follow.

The literatus and the theologian who adopt socialism do so, from what may be, under the circumstances, psychological necessity. They see on the one hand poverty, and on the other wealth, and they reason that, if the wealth were evenly distributed, all would be better off.

They are profoundly ignorant concerning the practical mechanism of the industrial system.

They demonstrate beyond question their ignorance when they assert that, under free competitive conditions, the general rate of profit is too high.

The difficulty of making a profit large enough to insure success in business has always been so great as to cause about ninety per cent. of those who have tried it to fail!

Now, it seems to me that when a man is confronted with the fact that the chances for profit-making are so narrow that a majority of those who try for it lose money instead of making, he ought to begin to suspect that they who succeed owe their suc-

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cess not to any general condition common to the industrial system, but to special conditions which they themselves have created.

The capitalist who succeeds as a manufacturer does so in the face of the most determined war of competition, wherein each competitor strives to impart greater value in exchange for what he receives than anybody else can do. Can Socialism beat that?

To say that the man who succeeds under such circumstances is not justly entitled to all that he can get out of the situation is an outrage upon common sense!

I say that the intricacies of the mechanism of exchange have so completely hidden from view the chain of sequence of the natural law that operates in the premises as to entirely mislead the political economists of all schools.

Not one of them but will assure you that, if you increase the margin of profit, it must be done by diminishing the rate of wages. Or, on the other hand, that if you increase the general rate of wages, it can only be by cutting down profits.

Now, I wish to clear up the mystery that enshrouds the element of exchange, and I can best do so by employing a certain circumstance of ancient history for illustration.

When Pharaoh, in exchange for corn, purchased all the land of Egypt, he took one-fifth of the products thereafter as rent.

This, then, was the cost of government to the Egyptian people.

Now, suppose we represent the year's industrial product of Egypt by 100
Pharaoh's share would be..... 20=20%
Leaving the people..... 80=80%

No matter what were the prices at which products were sold; no matter what the rate of wages or of profit, Pharaoh's share (that is, the cost of government) would be just 20% of the gross product.

But now let me show you a little trick by which Pharaoh might have greatly increased his income at the expense of the people without their knowing anything about it. At least I do not think they would have suspected anything, because the scheme has been in good working order from that day to this, and is still in successful operation, and the people have not found it out!

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Suppose that instead of pursuing the system of barter, as was common in all early civilization, Pharaoh had introduced the modern system of using money as the general medium of exchange.

Let the selling price of the year's industrial product of Egypt be represented by.....$100
Pharaoh's share would be..... 20=20%

And the people's share..... 80=80%

Very good. So far, there is neither loss nor gain to either party.

But now, Pharaoh's annual salary is fixed just as the salary of the president of the United States is fixed, and it must be paid —just so much money every year.

Now Pharaoh, on the advice of Joseph (who had already proved himself an expert financier) convinces the people that they would be just as well off on a low price scale for commodities as on a high price scale.

The employers, acting upon Pharaoh's suggestion, cut wages and profits twenty-five per cent., which would make the selling price of the year's industrial product $75 instead of $100. What would be the result? Let us see:

Selling price of year's product.....$75
Pharaoh's share ..... 20=26 2-3%

Leaving the people ..... 55=73 1-3%

That is to say, whereas, before, the people could buy for their own use, 80 per cent. of their product, they can now buy only 73 1-3 per cent., while Pharaoh's purchasing power has increased from 20 to 26 2-3 per cent.

If the average margin of profit, prior to the reduction of prices, was six per cent. of the product, that would have left the wage-people 74 per cent. Now, after the reduction, if we wipe out profits entirely, and give to the wage-people the entire product, minus Pharaoh's share, they will receive two-thirds of one per cent. less than they got before, while the capitalists will get nothing at all!

A never-failing feature attendant upon a period of business depression is the chorus of sympathy that goes out for the suffering poor among the unemployed work-people.

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This is all right; it is just as it should be. But what about the thousands of employers whose mills and factories stand idle, and whose capital is being swallowed up by stagnation?

Howsoever bad the times may be, they never get so bad but that the workmen who have employment receive wages. But the same can not be said of capital, however. During periods of extreme business depression, hundreds of millions of capital works without receiving any profit whatever, and other hundreds of millions actually pays for the privilege of working!

In point of fact, in periods of extreme hard times, the wage people, as a class, get far more than an equitable share of the current product; the capitalists (that is, the employers) being compelled, by stress of competition, to subsist upon the accumulations of the past; that is, by consuming their capital.

It may be hard for some people to believe it, nevertheless it is true, that at such a time the employers sympathize with the unemployed poor as deeply as anybody else, and they do vastly more to relieve them than all other classes combined.

I wish, however, to call attention to a certain class of people who never find any fault with hard times on their own behalf.

Reverting to the case of the Egyptians, Pharaoh stands as the type of this class. His income is fixed. The more the people suffer, the more wages, profits and prices fall, the more he is enabled to buy with his undisturbed income. If Pharaoh has a thousand salaried officials in his government, they are in like case with him. They grow fat while the people grow lean. It has been just the same from Pharaoh's time to the present day.

The cost of government does not diminish simultaneously with the fall of prices of commodities in times of panic and business depression.

In the memorable year of 1893, when the business of the country went to pieces, hundreds of thousands of wage people were thrown out of employment, and hundreds of millions of capital vanished from existence, both the revenue and the expenditure of the United States government were greater than for the year before.

Now we cannot, within the time at our disposal, analyze minutely the economic conditions that prevailed during that calamitous year, but we can, by glancing briefly at some of the prominent facts, gather knowledge that should enable us to prevent a recurrence.

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The aggregate selling price of the products of industry constitutes the fund from which the cost of government and all other expenses of the people must be paid.

Does it need any argument to convince intelligent men that the higher the aggregate selling price, within limits, the better for the producers?

Suppose the total selling price of the aggregate product of the United States for one year to be, for instance $8,000,000,000.00

And that the cost of government consumes ¼ of it, or 2,000,000,000.00

This would leave $6,000,000,000.00

that could be applied by the people to the purchase of commodities, and for all other conveniences of life.

Under the circumstances, the public servants—government officials, etc.—are able to purchase 25%

of the year's industrial product, while the people's share of the price, which remains after paying public expense, is 75%

Now, the question is: If we reduce wages, profits and prices of industrial product generally, and in uniform proportion, will the workmen and the employers be able to still purchase the same amount as before; that is, 75 per cent. of their product? Let's see:

Suppose we cut wages and prices 25 per cent.. $8,000,000,000.00

Minus 25 per cent., or 2,000,000,000.00

Leaves the selling price of the year's product at. 6,000,000,000.00

The cost of government remains as before; that is 2,000,000,000.00

Which, deducted from the selling price, leaves for the people's other uses 4,000,000,000.00

This represents only 66 2-3 per cent. of the year's product, while the two billion dollars which goes to government cost represents 33 1-3 per cent. of it.

Before the reduction, the purchasing power of the producers, namely, the employers and workmen, was equal to three-fourths of the whole product, while after the reduction it is equal to but two-thirds of it.

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If we cut wages and prices 50 per cent. instead of 25 per cent., the selling price of the year's product will be four billion dollars—and it will take half of it to pay the cost of government, leaving the employers and workmen in possession of a purchasing power equal to but one-half of their product instead of three-fourths, as at the outset.

But the story of disaster is not yet more than half told! Where are we going to sell this 25 per cent. of the product that the employers and workmen used to buy?

We may surrender one-third of our purchasing power to the recipients of the fixed or non-competitive prices if we choose to do so. But what will they do with it? This is a very important question to you and me. If they do not immediately take to buying the things that we have, per force, stopped buying, and this, too, to the same extent as we did, a large per cent. of our product will remain unsold. Will they do it?

If they do not then the people who make and sell them will be in a bad fix, with an excess of product 25 to 30 per cent. beyond the demand.

The recipients of the non-competitive prices have the power to buy all the excess of product which we formerly consumed, because we have transferred to them that power. But they do not wish any more of the common commodities of production than they had already been in the habit of buying.

What will be the inevitable result? Simply this, that we shall be compelled to curtail production in most of the various lines of industry. We have stupidly curtailed our own purchasing power, surrendering it to a class of people who will not employ it in purchasing the things that we produce beyond what they had already been doing. And there is nothing for it now but to cut down production, necessitating the discharge of hundreds of thousands of workmen, and overwhelming in bankruptcy thousands of capitalists.

And now the recipients of the fixed prices, and the people whose wealth shall happen at this moment to be in money, or in mortgages, will know just what to do with the increased power that we have graciously given them; they will use it in buying up our fixed capital at a fraction of its original cost, or they will get it by foreclosing on the mortgage.

The United States is the most prosperous country in the

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world because we pay higher wages than any other country. Mark the distinction—we do not pay higher wages because we are more prosperous, but we are more prosperous because we pay higher wages. Because the cost of government here does not consume so great a proportion of our product—because the competitive prices bear a more rational proportion to the fixed prices than in any other country.

It will have been observed that when I have spoken of a decline in the wage-rate, I have invariably assumed that profits and prices of commodities also fall. I have not considered it necessary to make any argument to support a proposition which is verified by all the industrial history of the past.

It is impossible to maintain a given margin of profit on a reduced wage scale; nay, I will go farther and affirm that it is, and, in the very nature of things, must always be impossible to maintain a given margin of profit in a rapidly progressing society. For with expanding intelligence and more nearly universal high education, the proportion of men who compete for profit increases far more rapidly than that of those who compete for wages in the common ranks. Every man who rises from the ranks of mechanical labor to compete for profit diminishes the stress of competition for common wages and intensifies the competition for profit. This being true, there is no danger of profits being too high under circumstances where free competition prevails.

To get an idea of what competition would do to the margin of profit, imagine a general reduction of wages to the extent of 25 per cent. Assume that there are ten millions of wage workers receiving an average of two dollars per day per man:

10,000,000 x $2=$20,000,000.00, and 25 per cent. of this is $5,000,000.00.

Now if we have made this 25 per cent. cut in wages in the hope of increasing the margin of profit, we must not permit prices to fall. But what about these goods to the value of five millions of dollars every 24 hours, which the workman formerly bought, but which he has not now the power to buy? What shall be done? We must act quickly, for in a week's time it will be thirty million dollars' worth; in two weeks sixty, in a month one hundred and twenty millions of dollars' worth of goods beyond the usual surplus for which there is absolutely no demand! We

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have deprived the workmen of the power to buy them, and we ourselves are not going to increase our purchases under conditions like these—with warehouses bursting with rapidly accumulating goods.

What shall we do—wait another month and see how things may turn? Yes, and now there are two hundred and forty millions of dollars' worth of surplus goods. Who will buy them? We know that the workmen cannot, for we have cut their wages to just that extent. And you and I are not going to increase our purchases of other men's goods when we cannot sell our own product! In fact, we will cut down our expenses at every possible point. Yes, that's exactly what will happen; employers everywhere will "retrench"; and that means a still further falling off of demand.

But why carry the demonstration farther? We know just what has happened—the bottom has gone out of the market, and prices have fallen through!

The best possible industrial situation is that wherein demand equals supply.

If a man exchange his own product equitably, his demand equals his supply.

If all men exchange their products equitably, all demand equals all supply.

If we were doing business by the system of barter instead of by money medium, they who should impart more of value than they should receive would have to work just so much harder than those who should receive the advantage. But the *demand would still equal the supply*, and there would be no lack of employment.

However, since we use money as the universal medium of exchange, and since we fix a certain price for a large part of our expenses (namely, for the cost of government), a diminution of the rate of wages and of profit amounts to a surrender of our equity in exchange; and furthermore, as we pay the cost of government in money, the recipients are not bound to take our products as they would be under the barter system, and thus, *demand falls short of supply.*

This is the worst possible industrial situation, because excessive supply intensifies competition, superinducing panic, and the wiping out of all profit. Here we have that condition which men in their ignorance of the everlasting natural laws operating in the premises have ascribed to overproduction.

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Advance the general wage rate far enough, and consumption will absorb the utmost possible supply.

If the present industrial system is to survive, it will be because its sponsors shall perfect it to such extent as to employ every man all the time at wages that shall represent the full value of his service.

Society owes no man a living, but it owes every individual a fair chance to make a living for himself; nay, more—it owes each individual a chance to produce all that he can under the most favorable conditions and to exchange his service for equal service.

If what I have said is true, then I have demonstrated with mathematical certainty that the interests of labor and capital are identical, and that the true interests of both are best promoted by an ample and perpetually sustained general wage rate.

There is no possibility of legitimate conflict between the wage-workers, so-called, and their employers, but there is conflict of financial interest between the recipients of the fixed prices and the recipients of the competitive prices. As the latter, namely, the workmen and the employers are greatly in the majority, and as the regulation of the wage-rate is wholly within their power, they can, at will, enhance the value of the fixed prices by reducing the wage-rate, whereupon "Competition" among employers to sell their goods in a market where the element of "Demand" has been arbitrarily curtailed, will scale down the margin of profit, and, therefore, the selling prices of commodities from the aggregate of which the undiminished cost of government must be paid; or, they can diminish the burden of the fixed prices by increasing their own prices through the medium of advancing wages until demand and supply shall balance.

Thus equity in change will be accomplished as nearly as that shall be possible so long as any kind of monopoly shall exist.

Maintain a universal wage-rate rationally proportioned to the salaries of public officials and the per capita expense of government; then bring on your labor-saving machinery and every possible improvement in the arts of production; the never-failing demand will consume the utmost possible supply; the tramp will disappear from the social realm as quietly and as naturally as he came; the slums will vanish from our cities; poor-houses will be turned into kindergartens; by degrees the jails and prisons will

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be changed into technical schools and mechanical institutes, and the millions of intellects, emancipated from the trammels of poverty by the enlightening and liberating genius of universal affluence will speedly harness the forces of nature to perform the painful toil that now engrosses the major part of human force, thus setting men free to engage in those higher labors through which mind shall rise to its destined supremacy over material things, and man, created in the image of God, shall stand forth in all the dignity and beauty that pertains to the children of the King!

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VOL. X. JUNE, 1901. PART I.

MELTING BRASS.

By MR. C. VICKERS, Chicago, Ill.

Brass, bronze, and other copper alloys are seldom melted in contact with the fuel, as in the case of iron. Crucibles are universally used, the furnaces are simple in construction, and so well known as to need no description. Solid fuel is most generally made use of, either hard coal, or coke, coal being the best for furnaces with forced draught. Liquid and gaseous fuels are also used in melting, but will never entirely supplant the old straight shaft furnaces. This is not because brass founders are conservative as a class, and object to change, but rather that their foundries are generally small affairs, and located in all of out of the way places, such as the upper floors of high ings, and places possessing no railroad facilities. Under such conditions oil cannot be obtained at a price that will allow it to compete with coal or coke. The use of oil also in crowded cities increases fire risks. Gas may be easily obtained, but its application to brass melting requires the attention of specially skilled workmen in order to be efficient and economical. Gas, however, is an ideal fuel; it is clean, easily regulated and applied, and leaves no ashes to carry away metal, but such is the ignorance and prejudice of the average melter, that manufacturers of gas furnaces, convinced that their furnaces will never get fair treatment at the hands of these men have retired from the field in disgust, and no longer seek to place their products in the average brass foundry.

Whatever kind of furnace may be used the melting and handling of copper alloys, requires the most careful supervisio. on the part of the management, or the loss of metal will be great, that it plays havoc with the profits of the business. Thi. loss is greater in summer than in winter, as the great heat to which the men are exposed, saps their vitality and makes it impossible for them to stand up to their work as well as in cold

weather. More metal is therefore spilled in the furnaces, and lost by oxidation. The ashes and skimmings should receive careful attention, and the recovered metal be promptly used up. The cost of melting may be greatly increased by the injudicious handling of crucibles.

As the subject of crucibles has been exhaustively and ably dealt with in a former paper read before this association, the present writer will content himself with a few remarks on tongs, as ill-fitting tongs bring many crucibles to an untimely end. Some brass foundries habitually use tongs with only one set of straps; tongs such as this are very liable to crush the pot, especially when used for pouring. They grip the pot a little below the bilge when the lip of the pot is rested on the edge of the mold and the tongs pulled over to lip it in pouring, if the tongs do not grip with great force the leverage will cause them to slip, and this is fatal to the successful running of light work. The pressure of the tongs being great enough to hold the pot firmly, it is soon squeezed out of shape and becomes oval. This continues until a crack is developed and the further usefulness of the pot is ended. Tongs with two sets of straps are the best, one set gripping below and the other slightly above the bilge. They are very liable to warp out of shape, however, and should be fitted from time to time to a new pot. Tongs with ace of spade shaped points, the ace gripping below the bilge and the straps around the same ought not to be used in "pulling out," as the fuel will often prevent their going to place, and the points of the ace grip the pot where they are not intended to fit and they sink into and pierce the softened pot.

To obviate these troubles furnaces have been devised, from which the crucible is never removed. The metal being poured out by tipping the furnace. This is all right on heavy work, but is useless on work where the metal must be used "jumping hot," as the transference to a pouring vessel will inevitably cool it. For exceedingly light work experience has taught that small crucibles and tong pouring are the best.

It is a good idea to have two spouts to a crucible, one at right angels to the other. This second spout can be easily made with a file, before the pot is used. Then if both spouts are used alternately in pouring, the pot will retain its circular form and not be so liable to crush.

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Crucibles are often broken when melting ingot copper and heavy pieces of brass, by carelessness in packing the same when the pot is charged. Each ingot should rest on the bottom of the pot and not be suspended by other ingots on the sides of the pot, otherwise when melting commences these suspended ingots are liable to act as a wedge, and in sinking burst the softened crucible.

When brass is melted with ingot copper it is often good practice to melt the brass first, placing the copper ingots on top of the pot and when hot dropping them into the melted brass. This will cut them away, bringing the heat out quicker.

Sometimes crucibles will fail from no fault discoverable in the furnacemen's method of handling them. They have been known to leak one after the other, about the third or fourth heat, when they should have lasted at least twenty. In the writer's experience, such leakage has often come from minute holes which developed, out of which the metal oozed in drops. Brass founders have contended that this arose from some defect in the material of which the crucibles were made. While this is not admitted by the makers they allow that many crucibles, made in the year 1899, were not up to standard and gave a very plausible explanation thereof.

"Owing to the exhaustion of the reserve stock of plumbago, due to the enormous demand which arose on the revival of business in that year, everything that would pass as plumbago was sold to the crucible makers, and therefore the defects noticed may have occurred from the use of imperfact material when the better grade could not be obtained."

Early in 1900, however, things changed for the better, good material became again obtainable and makers report for that and this year so far, "unprecedented runs of a goodly number of heats."

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EFFECTS OF VARIATIONS IN MANGANESE ON DIFFERENT GRADES OF IRON.

BY MR. THOS. D. WEST, Sharpsville, Pa.

The results shown in Tables 1 and 2, obtained from a wide range of experiment, verify some of the properties attributed to manganese, and, the writer believes, amplify our knowledge of its effect on cast iron considerably. We will first outline the method of physical testing followed in this work.

The breaking strength and deflection given in columns 3 and 4, Table 1, are each the average of about four tests. Two of the tests being from $1\frac{1}{8}$ inch round bars cast on end, and two from 1 inch square bars cast flat and used for obtaining the contraction and chill. All bars were tested 12 inches between supports.

The contraction tests recorded in column 5, Table 1, were obtained by casting square bars A and B in a frame C, Fig. 1. The contraction was measured by a graduated wedge D, the thickness of the point at which it settled between the bars and frame being measured by a micrometer, as at B, Fig. 4. The bars were 1 inch square by 24 inches long and poured by top gates, as shown. The chill was obtained by breaking off a piece at the ends as shown at B, Fig. 4.

To obtain the hardness tests, the writer arranged a drill press, as shown in Fig. 2. A bicycle cyclometer was attached to the upper body of the frame, at F, and then a light sheet iron ring was bolted to the upper shaft G, with an arm as at H. This arm came in contact with the cyclometer at every revolution of the shaft G, and recorded the exact number of revolutions made in a stated time by a watch held in the hands of the operator. as seen at I. In order to apply a constant pressure of the drill J on the test piece K, a weight Z was suspended from the lower arm M, by a wire, at a given distance from the end, as shown.

TABLE 1.

	1 No. of test	2 Iron used.	3 Breaking Strength.	4 Deflection	5 Contraction.	6 Chill.	7 Hardness.	8 Structure.
Heat No.1	1.n	Foundry pig.	2,169 lbs.	.107"	.180"	None	.572	4
	2.	Mn. in cupola	2,268 lbs.	.110"	.231"	None	.122	5
Heat No.2	3.	Foundry pig.	1,715 lbs.	.101"	.198"	None	.625	5
	4.	Mn. in cupola	1,808 lbs.	.082"	.237"	Slight	.415	5
Heat No.3	5.	Charcoal pig.	1,510 lbs.	.075"	.276"	None	.438	3
	6.	Mn. in cupola	1,822 lbs.	.090"	.291"	None	.410	4
	7.	Mn. in cupola	1,654 lbs.	.072"	.315"	.025	.248	5
	8.	Mn. in ladle.	1,577 lbs.	.077"	.284"	None	.506	2
Heat No.4	9.	Foundry pig.	1,428 lbs.	.101"	.125"	None	.730	3
	10.	Mn. in cupola	1,690 lbs.	.102"	.204"	Slight	.600	5
	11.	Mn. in cupola	1,763 lbs.	.083"	.161"	None	.705	4
Heat No.5	12.	Foundry pig.	1,652 lbs.	.105"	.216"	None	.553	3
	13.	Mn. in cupola	2,269 lbs.	.130"	.260"	Slight	.107	6
	14.	Mn. in ladle	1,995 lbs.	.100"	.229"	None	.532	4
	15.	Mn. in ladle	2,016 lbs.	.100"	.246"	None	.578	4
	16.	Mn. in ladle	2,122 lbs.	.095"	.279"	Slight	.490	5
Heat No.6	17.	Foundry pig.	1,888 lbs.	.100"	.309"	None	.347	3
	18.	Mn. in cupola	1,794 lbs.	.097"	.320"	None	.282	3
	19.	Mn. in cupola	1,845 lbs.	.080"	.330"	.062	.204	3
	20.	Mn. in ladle	1,970 lbs.	.102"	.309"	None	.314	3
HeatNo. 7.	21.	Charcoal pig.	2,355 lbs.	.095"	.339"	.128	.385	7
	22.	Mn. in cupola	2,331 lbs.	.090"	.348"	.166	.244	7
	23.	Mn. in ladle	2,394 lbs.	.100"	.341"	.055	.450	5
	24.	Mn. in ladle	2,310 lbs.	.102"	.340"	.040	.328	5
Heat No.8	25.	Bessemer pig	1,701 lbs.	.125"	.226"	.300	.420	3
	26.	Bessemer pig	1,497 lbs.	.055"	.242"	All White	White	White
Heat No. 9	27.	Charcoal iron.	1,570 lbs.	.052"	.401"	1.375	.040	Mottled
	28.	Mn. in cupola	1,082 lbs.	.046"	.427"	All White	White	White
	29.	Mn. in ladle	1,772 lbs.	.100"	.326"	1.100	.242	3
	30.	Mn. in ladle	2,066 lbs.	.095"	.322"	.230	.222	3

TABLE 1.

9 Sil.	10 Sul.	11 Mang.	12 Phos.	13 C.C.	14 G.C.	15 Total C.	1 No. of test
4.53	.025	.52	.194	.06	2.98	3.04	1.
4.40	.018	6.12	.178	.28	2.61	2.89	2.
4.51	.031	.48	.203	.07	3.19	3.26	3.
4.41	.023	2.62	.198	.23	3.01	3.24	4.
4.45	.110	.41	.213	.03	3.06	3.09	5.
4.31	.067	1.09	.210	.05	3.10	3.15	6.
4.30	.032	4.09	.192	.16	3.09	3.25	7.
4.52	.108	.51	.211	.03	3.05	3.08	8.
3.92	.034	.44	.164	.06	3.35	3.41	9.
3.88	.029	1.08	.156	.19	3.16	3.25	10
3.88	.029	.76	.162	.08	3.29	3.37	11
3.88	.031	.49	.194	.09	3.06	3.15	12
3.53	.020	3.53	.152	.30	2.87	3.17	13
3.82	.026	.68	.193	.11	3.22	3.33	14
3.62	.025	.87	.191	.11	3.39	3.50	15
3.74	.025	1.18	.192	.10	3.03	3.13	16
2.47	.030	.97	.255	.42	3.44	3.86	17
2.40	.022	2.26	.250	.45	3.38	3.83	18
2.41	.022	3.71	.231	.47	3.25	3.72	19
2.56	.038	1.16	.254	.40	3.44	3.84	20
1.88	.039	.26	.458	.61	2.92	3.53	21
1.69	.036	2.43	.435	.64	2.82	3.46	22
1.89	.035	.67	.455	.50	3.02	3.52	23
2.06	.033	.78	.457	.47	3.11	3.58	24
1.34	.076	.54	.087	.61	3.28	3.89	25
1.30	.061	5.11	.076	3.41	.17	3.58	26
.53	.070	.34	.407	1.14	2.66	3.80	27
.63	.042	2.84	.365	3.53	.15	3.68	28
.69	.068	.69	.420	.49	3.41	3.90	29
.74	.060	.74	.424	.62	3.28	3.90	30

Three revolutions of the shaft G, equalled two of the drill. The machine could be stopped in a second by a lever at M. The same ½-inch drill was used for all tests, testing the softer specimens first, and the harder ones last. The drill was kept of a uniform sharpness for the bars of each cast. The drill ran 60 seconds for each test and the speed of the shaft G varied from 35 to 37 revolutions. An average of 36 revolutions was allowed in computing the depth of the holes made in 60 seconds and recorded in column 7. The tests obtained by this drill press proved very satisfactory. To obtain the depth of the hole a wooden pin O, Figs. 3 and 4, was set into the drilled holes, as seen at P, and a steel pin R, pressed into the wooden pin on a level with the top of the test specimen, as shown at R. After the pin O was removed it was set on a level clean surface, a wedge T passed along until it was stopped by a pin, as at U. The distance the wedge passed under the pin U was measured by a micrometer as at V, Fig. 4. The depth of such holes could also be measured by filling them with water and measuring it with a small graduate.

The structure, column No. 8, is given merely to denote distinctions as made by the eye in judging the relative size of the crystals or grain of the fracture. For example, No. 2 stands for what would be expected of the grain in a piece of true No. 2 iron, and so on up with closer iron in the higher numbers.

The iron was melted in the twin shaft cupola, seen in Fig. 5, the operations of which have been explained by the writer in previous papers. The use of such a cupola seems to be the most reliable way of making comparative tests on work which involves delicate observations, and presents the remarkably uniform conditions of fuel, blast, heat, etc., necessary to discover the true effects of changes in the elements composing cast iron. The fact that the tests in Table 2 were obtained with the use of the cupola, Fig 5, gives the writer greater confidence in the results shown than he could place in any others obtained in the ordinary way of making separate comparative tests, that is, having one taken off one day and another some other day, with the differences in fuels, blast and heat conditions that usually exist in making heats in ordinary cupolas.

In charging the cupola, Fig. 5, small pieces from the same pig were placed in each compartment and the ferro-manganese

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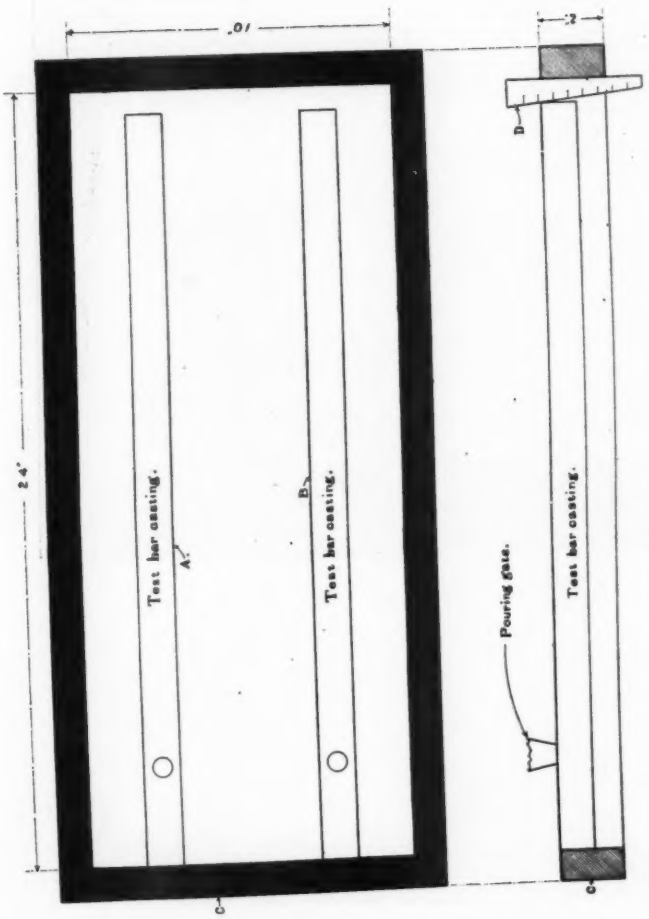
.01
.2
24"
Test bar casting.
A
B
Test bar casting.
C
D
Pouring gate.
Test bar casting.
C

Fig. 1.

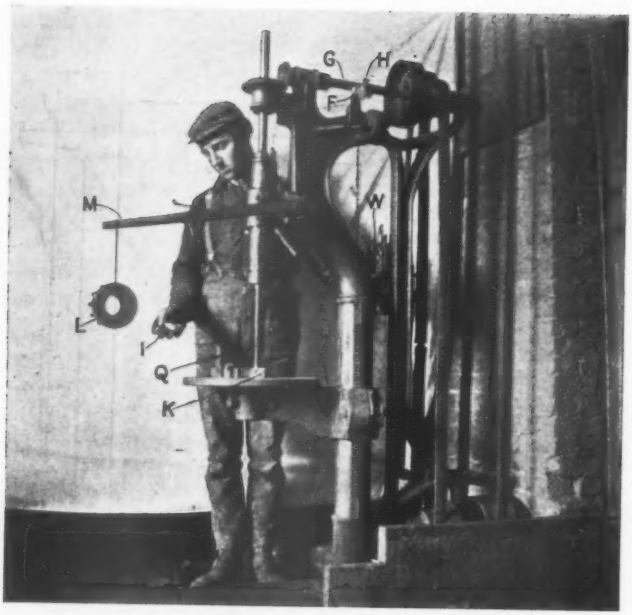

Fig. 2

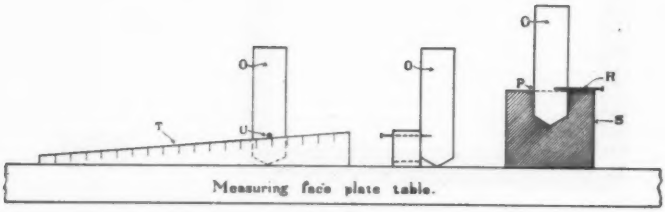

Fig. 3.

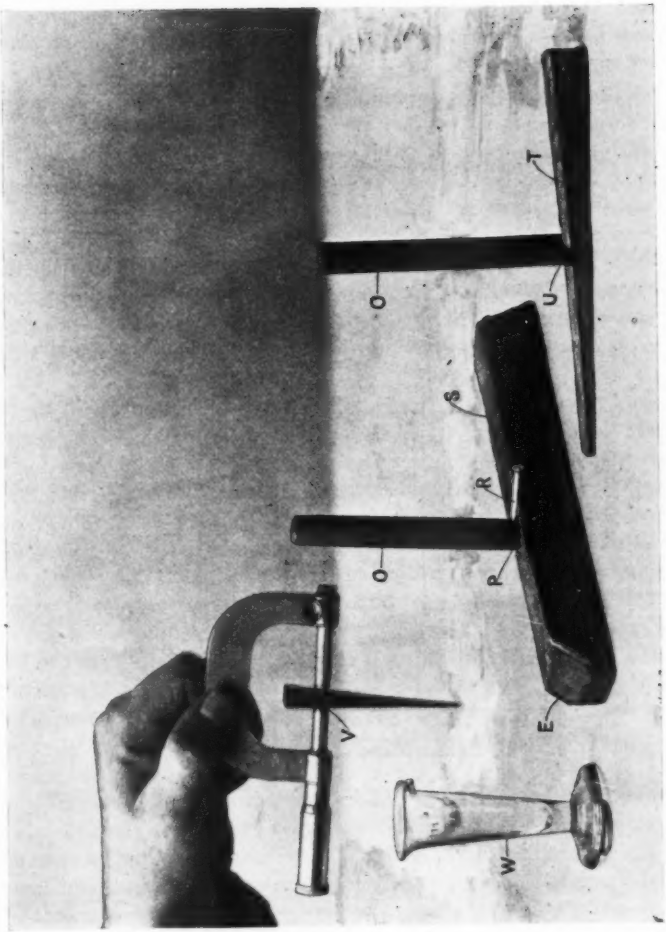

Fig. 4.

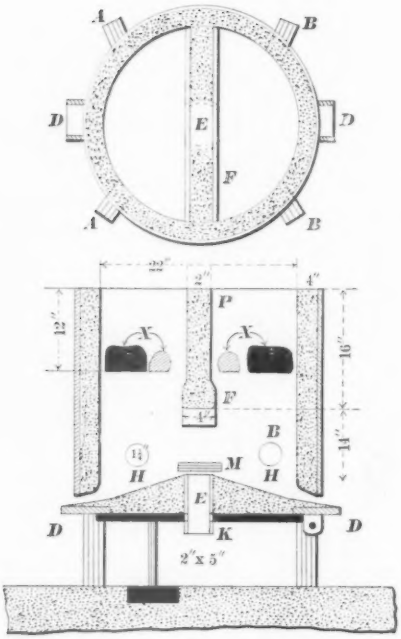

Fig. 5.

placed in one side only. For the second and fifth heats, shown in Table 1 two charges of pig iron with different percentages of manganese were made in the side containing the manganese. The weight of the charges were from 45 to 60 pounds of iron with a range of one to three pounds of manganese mixed with the charges. Heats Nos. 1, 2, 4, 5 and 6 were made of foundry pig iron. Heats Nos. 3, 7 and 9 of charcoal pig iron, and heat No. 8 of Bessemer pig iron. The analysis of the ferro-manganese was silicon 1.65, manganese 80.34, phosphorus .354, total carbon 5.85, and no sulphur.

In adding manganese to the metal in the ladle (this metal was always that coming from the side of the cupola free from the ferro-manganese mixture), it was broken to the size of a pea and thrown gently on top of the molten metal, and then stirred well with a half inch rod until all melted and in mixture with the iron which came down as hot as is generally the case with stove plate.

The 210 analyses shown, along with the extra work of cross-checking, were made by Mr. H. E. Diller, of the Pennsylvania Malleable Company, Pittsburg, Pa. The writer and the Association are greatly indebted to Mr. Diller for his work in making gratuitously such a large number of analyses. We have also in this connection to thank Prof. A. W. Smith, of the Case School of Applied Science, proprietor and manager of the Foundrymen's Laboratory, Cleveland, O.; Mr. Frank L. Crobaugh, proprietor and expert of the Foundrymen's Laboratory, Cleveland, O., and D. K. Smith, chemist, Claire Furnace, Sharpsville, Pa., for their able services in checking the combined and graphitic carbon determinations, a work done in order to increase the confidence in the determinations of carbon.

The moulding, casting and testing of the bars was all performed chiefly by the writer, as he believes experiments should leave as little to other parties as possible. If the labor and material involved in this series of experiments were computed at the lowest ordinary rates, the cost would reach about $300.00.

In a general way, the addition of manganese to the iron in the cupola increases the hardness by raising the percentage of combined carbon, which means greater contraction and chill, with a decrease in deflection and elasticity. While it is true

that manganese in cupola mixtures has the tendency just mentioned, a study of the tests given in Table 1, will show that the variation of manganese generally existing in any one grade of pig iron will have very little, if any, effect on the physical properties of the casting. Something which is entirely different from the changes due to the silicon and sulphur of irons coming from any one mixture of ores, flux, and fuel. A good test demonstrating this point is found in heat No. 6, which has 2.47 silicon in foundry pig when remelted. Here we find that an increase from .97 to 2.26, a difference of over 1.25 per cent., of manganese in the same pig does not cause a chill in the ends of the 1 inch square bars, when tested as at E, Fig. 4, and has only a difference of .011 in the contraction. By increasing the manganese still higher, until we have 3.71, nearly 3 per cent. of an increase, we then obtain a chill of only .062 in the ends of the bars, as at E, Fig. 4, and a difference of only .021 in the contraction over that found in the test bars free of the ferro-manganese mixture. Then again, the hardness tests, column 7, show a difference of but .065 and .143 in the depth of the drilled holes, as at P, Figs. 3 and 4, with the two variations in manganese. Still further, the structure, column 8, of the gray body, exhibits no difference to the eye. Another point shown by this heat comes from the manganese placed on the molten metal in the ladle. Here we find that an increase of .19 in the percentage of manganese has made no difference in the contraction and a variation of but .033 in the depth in the hardness test. This shows that the addition of manganese in the ladle tends to increase the hardness, which is contrary to what we have generally been led to believe by writers in the past. We are not confined to this one test to modify views of the past on this point, as the same result is also shown in heats No. 4, 5 and 6. However, when we get to low silicon irons, as in heats No. 7 and 9, we find that manganese in the ladle is very effective in throwing out graphitic carbon, or softening the iron, and very sensitive as it produces radical changes in these points.

In regard to the effect of manganese on the strength of cast iron, its tendency, as shown, is to make iron stronger. In adding manganese to molten metal, the iron should never be dull, but as hot as practicable, in order that all the manganese may be melted in such a manner that a homogeneous mixture may

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result. Where iron is dull, a fracture may often show little bright spots or grains of manganese alloy that did not melt and mix properly with the iron. In such cases more harm is done than good. A study of the tests shows that the best results for strength were dependent upon certain percentages of increase. Anything above or below this was injurious. The increase of manganese in the molten metal ranged from 25 per cent. to 60 per cent. The effect of adding manganese to molten metal on the other elements, shows an increase in the silicon and decrease in the sulphur, with phosphorus remaining fairly constant. With the manganese in the cupola, the silicon, sulphur and phosphorus are decreased. The complete table of analyses affords us excellent food for study and information on these points.

One peculiarity noticed in making these tests is seen in the high manganese of tests Nos. 2 and 6, causing the sand to peel most freely from the castings and leaving a skin covered with flakes of graphite. Whereas, with the same iron free from the ferro-manganesed mixture, the sand stuck strongly to the casting. All the bars poured with the iron having manganese added in the cupola showed this effect to a greater or less degree. No doubt this is the cause of some castings made of the same pattern peeling much more readily than others, with the use of the same grades of sand or facing, and equal fluidity of metal, a phenomenon we have all been at a loss to understand.

In regard to differences noticable in the fluidity of the metal, there was little, if any, to be seen between the iron coming from either side of the cupola, but the addition of manganese to the molten metal in the ladle increased the fluidity considerably.

Where founders desire a "white iron" of the best strength obtainable in castings, heats Nos. 8 and 9 would show that it can be readily obtained by mixing ferro-manganese with good strong grades of low silicon pig or scrap iron. Of course, white iron can be obtained with the cheapest grades of old scrap, but this will be much weakened than when good iron and ferro-manganese are used. The amount of manganese seen in heats No. 8 and 9 with the low silicon iron, is sufficient to make a casting having a section from three to five inches thick all white when cast without the use of chill. Where sections are heavier a greater percentage of manganese will be required.

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It will appear rather odd to many to note the high silicon charcoal iron used in heat No. 3, as it is rare that such brands of iron exceed 2.00 per cent in silicon. This iron was obtained from the Jefferson Iron Company, Jefferson, Texas. The charcoal iron in heats Nos. 7 and 9 was kindly donated by the Seamen, Sleeth Company, Pittsburg, Pa.

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FOUNDRY METALLURGY.

BY MR. HERBERT E. FIELD, Ansonia, Conn.

With the hope of making this paper interesting to every member of the American Foundrymen's Association present, rather than to the few who have made a special study of this branch of foundry practice, I shall try to give to this subject a broader treatment than is generally accorded it. I have no intention of taking up to any extent, the scientific problems and investigations which are now being carried on by many of our chemists, nor do I believe that an argument or paper concerning the advantages of a laboratory in the foundry is what is most needed at the present time. I shall first try to give a brief idea of what results may be expected of a metallurgist, and of how these results may be best accomplished. Then I shall consider in detail the conditions necessary to further the use of foundry metallurgy. In conclusion let me bring up for your discussion and solution, three of the questions now most discussed by founders.

PRACTICAL RESULTS AND HOW BEST ACCOMPLISHED.

Does it pay? This is the first and all important question that comes to every founder when considering the advisability of introducing chemistry as a branch of his foundry practice. Many a foundryman, attracted by the manifestly increasing interest shown at the present time, stops and asks himself this question. It may look well on paper, and it may sound well, to say that we employ a metallurgist, or that we mix our iron by chemical analysis; but this is not a sufficient inducement to draw a foundry out of the well-worn ruts of its ancestors, and persuade it to accept this new method. Many conflicting arguments have been written on this subject, but I have yet to learn of a foundry that has given it a fair and thorough trial and then has relinquished it. The future of foundry chemistry depends,

however, upon the question: "Does it pay?" It may be truthfully said that the amount of saving depends to a great extent, upon the class of work in which a foundry is engaged, upon its methods, and upon the men employed. A foundry melting ten ton a day can hardly expect to support an expensive laboratory, and a high-priced chemist, neither can a small laboratory, with an inferior metallurgist, make an appreciable showing in a large foundry. Judgment must be exercised in the introduction of chemistry as well as in any other branch of our foundry work.

Furnace men admit that foundries buying on specified analyses are getting the best of the product turned out from the furnaces. All furnaces make more or less poor iron, and this is very apt to go to the one who buys without specification. If you did nothing but to have a competent metallurgist furnish you with analyses best fitted for your work, and to insist that the furnaces send you iron which would fulfill these analyses, you would surely get a much superior quality of iron. The ability to make use of that grade of iron which can be bought cheapest at various times, enables a laboratory to add much to the credit side of the ledger. The founder who is confined to the use of one of two brands of iron, and who cannot profit by a low price quoted on some other iron, is certainly at a disadvantage in competition with a founder, who by use of his chemical methods can buy at the best prices the market offers. Irons frequently run better than specified, and an analysis of the car shows that it will carry more scrap, or more of a cheaper grade of pig iron, which may cause a considerable saving on that lot of iron.

Other arguments in favor of the laboratory are: the knowledge that a uniform product may be expected from your cupolas, the assurance that you will have no complaint from your customers, or from your machine shop on account of hard castings, and the saving which comes in machining these castings. The modern foundry now, more than ever, is called upon for castings to answer rigid specifications. Many foundries are compelled to reject such orders or have the castings made by others. Castings which will in every way answer the most exacting tests, formerly required of air furnace charcoal iron, can now be made from a cupola, by the use of analyses, at a cost exceeding but very little that of our ordinary castings. If the founder of cast

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iron hopes to hold his own against his steel competitors, he must be in a position to offer the best quality at a moderate price.

These are but a few of the many arguments which might be brought forward to show the advantages of the use of metallurgy in the foundry. There are those who succeed and those who fail in every branch of business practice, and the most benefit will be derived from the use of metallurgy by those who best adapt it to their own purposes.

There are three methods open to foundries wishing to use foundry metallurgy. Each has its advantages and I mention them in passing to show that the small foundry need not burden itself with the expense of a metallurgist while the large foundries cannot expect to get the best results from the least outlay.

The use of furnace analyses as advocated by some writers on this subject is the cheapest method as far as the first outlay goes for mixing iron by chemical analyses; it is better than nothing. Especially is this true now that the No. 2 Soft and No. 2 Special irons have replaced the former No. 1 grade. These irons can be bought in some sections at a fairly low price, and if mixed by the Silicon analysis, they may be frequently used with a considerable saving over irons graded by their fracture. There is absolutely no guide to the quality of these irons, except by analysis, upon which their successful use entirely depends. But little can be said as to the reliability of furnace analyses. I have known them to closely coincide with those made at the foundry, but frequently they vary, and the founder takes a chance in relying on this method. I consider it, however, an advantage in many cases over the fracture method. You at least have some definite specification to which you can hold your furnaceman; it is a step in the right direction.

The second method is the one which is meeting with the best results in the foundries of larger tonnage: The employment of a competent metallurgist with a suitably equipped laboratory, and with sufficient assistance to enable him to assume the whole care of the iron. Your secretary informs me that there is to be a paper presented at this meeting on the relation of the laboratory to the foundry, and so I will refrain from discussing what is, in many respects, a very important phase in the development of foundry metallurgy. Foundries engaged in spe-

cial work will reap the greatest advantages from the successful laboratory. The foundrymen themselves must decide whether the quality and the quantity of their output will warrant the employment of a metallurgist. If they find that their competitors with whom they were able to compete are now, by the employment of metallurgists, securing orders which formerly came to them, they will be inclined to believe that what has been a wise step for their neighbor may be a necessary one for themselves.

There is, however, a third method opening to foundries who do not consider that their work warrants the establishment of a laboratory, viz.: the employment of a metallurgist by a number of foundries. This has met with some success. It certainly has the advantage of saving the expense of the laboratory. To a certain extent, also, it is a saving in salary, for chemists can be employed at a much lower salary than metallurgists, and a laboratory with one competent metallurgist at its disposal, who is not hampered by the detail of analytical work, should be able to successfully care for several foundries. This cursory treatment of a rather broad subject will give a founder who has not adopted the use of a laboratory an idea of the possibilities which are open to him and of the results which can be expected if it is introduced.

Turning from a discussion which concerns only those foundries which have no laboratory, we will consider a subject which to me, is even more important:

CONDITIONS NECESSARY FOR THE ADVANCEMENT OF FOUNDRY METALLURGY.

(The writer apologizes for any reference following which may be personal in its conclusions, and hopes that what is said will be taken as intended; to further the best interests of foundry metallurgy.)

One has but to read some of the recent articles on this subject to find out how small an advance has really been made. This is surely true if we are to judge by what has been written concerning the mainspring of foundry metallurgy: "The effect and conditions of the different impurities which go to make up different grades and qualities of cast iron." Professor Turner's statements, which really form the basis of our present foundry metallurgy, appear to have been taken as the axioms of foun-

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dry chemistry. They have been copied and recopied in different words by practically every writer who has attempted to discuss this subject in our trade journals. While these statements are true as far as they go, they are altogether too meagre a foundation on which to build the whole structure of mixing iron by chemical analysis. Too little attention has been paid to the fundamental principles which govern the action of the different impurities which go to make up cast iron. This ignorance which exists in regard to the properties of pig iron, and to the effect produced by the different elements which compose it is very fully illustrated in the collection of analyses furnished by the different furnaces, and published by S. R. Church. I simply mention this in order to show how little the makers of pig iron really know about their product, and its possibilities. One example will suffice. A well-known brand of high silicon iron shows the following as the average analysis for silicon and carbon: "Silicon 8 to 12, carbon 4 to 5." Anyone who knows anything about the nature of cast iron will realize that nothing short of an electric furnace or a miracle could produce any such iron. Comparatively few brands of iron ever run as high as 5 per cent. in total carbon, even in exceptional instances, and then the silicon is always less than 1 per cent. The maker who advertises such an analysis as quoted above either deliberately falsifies, or shows glaring ignorance of the iron which he sells. Such an erroneous statement as this can only confuse one who is looking for information on this subject.

One authority asserts that silicon is the only element that can possibly effect your product, or that at most, a knowledge of silicon and sulphur is sufficient to enable you to accomplish all that can be wished for in the perfection of your castings. The next writer as confidently asserts that carbon is the only element which can in any way effect iron, and he tells how unnecessary it is to pay any attention to the other impurities. Again we seek, and are told that shrinkage alone is necessary in the controlling of our mixtures, and we are to simply cast a few test bars each day, and to use a certain machine for testing them, and all that we have been looking for, even perfection itself, is at hand. The harmful effects of these statements can be fully appreciated by the chemist who, coming to our foundries from a technical or industrial school, attempts to follow the directions written by

men who are supposed to stand high in foundry matters. He had much better start with nothing to guide him than to attempt to fathom such contradictions and false statements. Those who know the least about foundry metallurgy seem to have written the most.

Another great drawback to the advancement of metallurgy in our foundries has been the poor preparation which chemists have received in our schools and colleges. I called attention to this in a recent article in "Machinery," and I can do no better than to quote a paragraph written at that time:

"There are small foundries connected with many of our technical colleges, and some of them are fairly well equipped. There is, however, but little, if any, connection between the metallurgical and foundry departments. The foundry is generally operated by a practical moulder, who gives the students instructions in simple moulding and core work, and perhaps shows them about the construction and care of a small cupola. The metallurgical department is conducted by a member of the faculty who has probably never seen the inside of a large foundry, and whose notes are derived from old authorities, with perhaps a note or two picked up from some of our scientific periodicals.

"There are two questions upon which the success of this method of training foundry chemists depends. First, Are these institutions ready to take hold of the matter and pay the salary that a man competent to do this work would expect? Second, Could men be spared from foundry work who have the required amount of experience and who have acquired a sufficient knowledge of this subject to make the teaching of it a success? If these two questions can be answered in the affirmative, there is but little doubt that an institution which has a cupola and a foundry, could supply at the end of the course, students who would be competent to go into a foundry with a saving of at least a year of experimental work. These students could, under the direction of such an instructor, analyze the pig iron, make up the mixtures, and analyze and test the result. They could have a knowledge of the sampling of pig iron, and of the proper way to fit up a laboratory for foundry work. The newness and lack of experience is one of the hardest things which the chemist has to overcome in his first foundry practice.

"The good that might come and the progress that might be

made in this same metallurgy, can hardly be estimated if it were taken up under proper direction by our industrial colleges. Expert foundry metallurgists admit that there is a great deal more to be learned in this line. The advance investigation, however, has to be carried on in spare moments, of which there are but few in a foundry laboratory. If, however, it were taken up by the colleges where a scientific research, rather than dollars and cents, is the principal object aimed at, much more would be learned and added to our practical knowledge of the subject. The experimenter with time at his command, and ample facilities for analyses and practice, could work out some of the problems which are now bothering foundry metallurgists. This is perhaps sufficient to give a brief idea as to how the graduate chemist may be made use of at the present time, and what the possibilities are for the future."

Mr. Carnegie's offer to an English school, of a scholarship to be used exclusively for original research in iron and steel, the results of which are to be published, is a big stride in the right direction. It is not for a moment to be supposed that scientific or industrial literature contains all that is known about the metallurgy of iron and steel. Many of the investigations have been carried on at the expense of employers who are not willing to have the knowledge, acquired at great expense, published for the benefit of others. It is for this reason, if for no other, that this branch of investigation should be carried on by our technical schools.

Inaccurate analyses furnished by second class laboratories, poor methods of sampling, a lack of knowledge of the needs of the foundries by the furnaces, and a lack of appreciation by our foundries of the conditions which surround the making of the pig iron, are but a few more of the hindrances which foundry metallurgy is overcoming in its efforts for complete success. The standardizing bureau of this association has done much to overcome discrepancies in the results of different laboratories. I understand that an effort is being made to bring together into an association, all the metallurgical chemists connected with our furnaces and foundries in the hope of overcoming some of the differences which now exist between the makers and users of pig iron. Next to the good which might be accomplished by investigation in our schools, there is nothing which would be of more

value to metallurgists than such an association. It deserves all the help that you can give it.

More briefly stated then, the following are the five conditions most necessary for the advancement of foundry metallurgy:

1. A better knowledge of the fundamental principles upon which it is built.

2. A sifting of the facts and fallacies which now exist in our literature on the subject.

3. A better preparation for our metallurgists.

4. Advance investigation under the guidance of colleges and schools.

5. A more uniform method of sampling and grading pig iron and a better understanding between our furnaces and foundries.

THREE QUESTIONS FOR YOU TO SETTLE.

In the introduction to this paper I promised to consider briefly three of the problems which have heretofore occupied the attention of founders. Each of these subjects is worthy of a special paper, and I suggest them at this time, hoping that a thorough discussion will settle the points in question and clear the way for further investigation along new lines. These questions are as follows:

1. Can two irons of the same analysis and of different properties exist. If so how?

2. Can coke iron be substituted for charcoal iron?

3. Are silicon and sulphur sufficient guides in the mixing of irons for general foundry work?

It is possible to have two irons of identical analysis, and yet of a very different physical structure. This statement is one most frequently brought forward by those who oppose the mixing of iron by chemical analysis. I must admit that this subject is almost threadbare from previous discussion, but I hope that a somewhat unusual treatment may throw some new light upon it. I shall not for an instant question the possibility of the statement that the above conditions can exist, and I consider that this fact shows that a more thorough education is necessary concerning the conditions surrounding the melting and casting of iron. It is a fundamental truth in the formation of all compounds that reactions take place along certain definite

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lines. If then, two irons of identically the same analysis and different physical properties can exist, there must be a reason. This reason lies partially in the inability of chemical analysis to distinguish between the different allotropical forms of the same substance. For example, we have the diamond, graphite, and amorphous carbon, all of entirely different physical properties, yet when treated by chemical methods, all give the one element, carbon. Silicon is known in two and possibly three modifications as are also sulphur and phosphorus. In fact, the very elements with which the chemist has to contend in cast iron, are the elements subject to such modifications. The difference in condition of these elements is wholly due to differences in heat treatment, hence the variation in physical structure in two irons of the same analysis must also be due to differences in heat treatment surrounding their formation.

Can coke iron be substituted for charcoal iron? Another subject which has caused many arguments, is that of the substitution of coke iron for charcoal iron for many foundry purposes. Can one be used in place of the other with the same result? This question can be answered in the affirmative, but it must be followed by rather a large "if." There is no doubt that with a proper selection of ores, using washed coke, and a careful attention to the detail of temperature in melting and casting, this might be accomplished. Many brands of charcoal iron are now readily duplicated in those of the coke furnaces. This is especially true of those grades advertised for their high tensile strength. A combination of coke iron can generally be made by analysis, which will exactly duplicate this charcoal iron. It is more difficult to duplicate the higher carbon irons used in the manufacture of car wheels, but even this has been equalled by the coke bessemer which is used for malleable purposes. The chief difference between the charcoal and coke iron with apparently the same analysis, is in the condition of the carbon. This is the same difference that exists between a piece of white iron properly annealed and one over-annealed. You can heat and plunge the former and change the free carbon back to the combined state, but if the graphite is sufficiently developed, as in over-annealing, heating and plunging have no effect upon this form of carbon. In other words the carbon in our coke iron is generally in a further developed graphitic state. The use of

iron pig beds in place of sand will in a measure overcome this difference, and in this statement may be found the true advantage of the iron moulds over sand moulds for furnace pig beds. The mere fact that charcoal or coke is used in melting or reducing the ore to the pig, does not signify that the irons will be different. The higher prices commanded by charcoal iron, enable a more careful selection of ores than is possible with coke iron. The use of coke iron in place of charcoal iron began extensively during a time when the coke furnaces were willing to meet any possible requirement in order to obtain contracts. This anxiety to fulfill narrow specifications entirely disappeared with returning prosperity, and gave way to a rush for tonnage which forced many founders who were having considerable success in the use of this iron, to return to those of the charcoal furnaces. The substitution of coke for charcoal iron lies to a considerable extent, with the furnaces themselves. The same care must be taken in the production of this iron which is exercised in the manufacture of our best Bessemer. It is probable that for a time demand would keep the price so near to that of charcoal iron that there would not be as much gain as might be expected to the founder.

Are silicon and sulphur sufficient guides in the mixing of iron by chemical analysis?

This one subject is worthy of a paper by itself. I bring it up as the conclusion of my paper, hoping to more clearly define the conditions in which one or two elements might be used successfully to control mixtures.

The advocates of this method have been men engaged in a limited line of work, and employing a limited variety of irons. If one is using Bessemer iron only, and is making but one line of work; and if he is so situated that he uses the product of a single neighboring furnace; in such a case I may safely say that silicon and sulphur analysis will be sufficient guides in mixing his iron. The same might be true for any foundry using a limited number of high class irons for a definite line of work, but the advocates of this method must in fairness conclude with this statement: "I use a limited number of the best irons; I make only one line of work. Only those in like circumstances need apply these conclusions." Thus would they help a few rather than to hinder many. A recent article states that all

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progressive furnace men and founders control their mixture by silicon and sulphur. I should hardly consider this probable, as I find that the same statement was made five years ago. It is hard to believe that our founders have made no progress in the use of metallurgy during the last half decade.

The per cent. of silicon and sulphur necessary to control irons of one kind will be wholly unsuited for those of another kind. An instance recently brought to my notice, will perhaps make this clear. A chemist went from an eastern foundry where Virginia and Alabama iron had been used to a foundry in a different section of the country where northern pig was principally melted. While awaiting the arrival of a carbon apparatus he analyzed the iron for silicon and sulphur. He made his mixtures with the same per cent. of these elements that he had formerly used with such good results. His iron came soft, kishy and full of blow holes. It appeared to be right as it came from the furnace, but it soon became thick; feeding rods were covered with a kish-like compound. This caused no end of trouble. Upon analysis of these irons for carbon, they were found to run much higher than any that he had used in the East, and he was obliged to greatly reduce the silicon before this difficulty was overcome. Had he made the analysis for carbon first he would have avoided this difficulty and have saved much expense.

The amount and condition of the carbon are the chief elements which regulate the qualities of an iron and make it hard or soft, strong or weak. Silicon and sulphur are elements whose usefulness consists simply in their effect upon the carbon. I am not siding with the carbon faction in a discussion of the usefulness of these two elements, but I am trying to make prominent the fact that no element can be disregarded in the mixing of iron by chemical analysis. The chief trouble with the iron made during the rush period was, that the irons were too low in carbon. An analysis for silicon would have been but little help to a founder whose iron had shrunk nor would an increase in the proportion of the silicon wholly avoid this difficulty.

"How high shall my iron run in silicon?" is often asked by founders in our trade journals. This question may be asked by a man who makes stove plate, and answered by a man who makes cylinders. No one can give the per cent. of silicon and

sulphur necessary without knowing the nature of the work, the quality of the iron and the amount and the kind of scrap. All these influence the amount of silicon necessary for different mixtures. If we are to profit by the advice of others, we must limit ourselves to those who have had experience in the line of work in which we wish for information. It is only natural to think that what has been of advantage to us must be of help to others, losing sight of the fact that no two foundries do exactly the same line of work or use the same irons, and that there are hardly two cupolas in the country which melt under the same conditions.

Foundries will profit then by the use of analysis, in proportion to the intelligence shown in its practice. The founder simply deludes himself when he considers that he is able to obtain the maximum benefits when using partial analyses. A benefit derived from mixing by silicon and sulphur is but an indication of the results that may be accomplished by making use of the full analysis.

In conclusion I wish to thank this Association for the privilege of presenting this paper at this meeting and trust that it has fulfilled, in part at least, the intention of the writer, to interest you both as individuals and as an Association in the advancement of Foundry Metallurgy.

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INSURING PATTERNS.

BY MR. FREDERICK CONLIN, BETHLEHEM, PA.

No single item is more in disfavor with the insurance companies than that of foundry patterns.

The value of the active pattern is the cost at which it could be replaced in the open market. It is a peculiar fact that the patterns representing the very essence of a foundryman's business is a less tangible asset than the scrap iron heap. There is no foundry asset so susceptible of fluctuation and difficult of valuation, and at the time of loss, so liable to suffer from the adjuster's depreciation charges, etc., as that of patterns. This is largely due to the fact that in case of fire the damage to patterns, as a rule, results in total loss. If not actually destroyed they are made valueless through the heat or water and generally a partially damaged pattern will cost as much to be repaired as a new one. In addition to this there is a difficulty in adjusting values. The bone of contention is the question of depreciation. A pattern which has cost many hundred dollars may be obsolete, or after having been used once may never be brought into service again, and is of no value, the cost of its production having been charged to the cost of making the casting. Other patterns may have been in use for a long time and subject to heavy depreciation charges. The pattern which may have been worth the cost of production last month may suddenly become obsolete and valueless. This rapid fluctuation between a useful tool and a piece of scrap wood illustrates the difficulty of adjusting losses. The element of cost being almost entirely that of labor, which is absolutely lost when the pattern is "scrapped."

An important law decision defines patterns as tools. The plaintiffs were manufacturers of machinery and kept wooden patterns to make the iron castings needed for the machines. The policy insured their fixtures, movable machinery, engines, lathes and tools, and it was held that the parties intended to include pat-

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terns in the word tools and that the policy covered all patterns which from their size and shape admitted of being applied and managed by the hand of one man. The underwriters were no doubt influenced by this decision as they at present stipulate that if patterns are included in a general policy, they must be specified in a separate item and a fixed amount stated as the limit of the risk assured on them. It is further required that the figure given must not exceed the per cent. of the amount of the policy. Under certain favorable hazards the limit is sometimes increased to twenty per cent. This is, however, exceptional.

An insurance official in discussing the question of patterns, expressed the following opinion: "The temptation to show a high value upon obsolete patterns is too great for some men and as a result insurance companies are frequently asked to pay high prices for patterns after a fire which were considered of trifling value before the loss. This is not a reflection against foundrymen generally. We base our estimates upon say 1,000 losses, and it takes but a very few individual fires where excessive claims are made to raise the average loss to a figure much above what we consider normal. This brings in the question of moral hazard which insurance companies are obliged to consider in connection with the risks which they assume. Again, as a rule, pattern shops which are extra hazardous are generally in close proximity to the place where patterns are stored. This adds considerably to the risk. Patterns should be stored apart from the pattern shop and if possible kept in detached buildings.

Another high authority gave the following views: "In considering insurance risks the rates are based upon the average loss of say one thousand fires. The average appraisal of loss runs less than 50 per cent. of the amount of insurance. If the underwriters should figure upon the basis of a total loss the present rates would be much higher. The trouble with a pattern, from an insurance company's standpoint, is that there is rarely any salvage. Hence when we have a loss with patterns, it is a heavy one and way beyond all proportion to the percentage of loss on the balance of the other classes of property unsaved. In other words there is no salvage to a pattern loss while with ordinary merchandise, it is sometimes surprising how much we recover from goods which have been in a litter covered with rubbish and ashes or soaked with water."

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"In practice where the assured is inclined to be fair and meets us halfway, it is rare for us to have a serious dispute as to these matters, we generally get together and settle the question without much loss of time."

Another official of a prominent insurance company gave the following definition of obsolete patterns:

"An obsolete pattern is one not liable to be used, and if the foundryman cannot show by his books that a pattern has been used in say five years' time, we consider it obsolete. The fact that a foundryman has put such pattern away and given it store room has no bearing upon its value. We store from time to time numerous papers and documents which we never expect to be obliged to refer to, and yet we give them house room having in mind the faint possibility that we may want to refer to them. The fact that we store these papers away does not make them valuable. I do not consider a pattern obsolete if you can take me a casting made from it and show me that such casting is in use. All active patterns and also patterns for castings in general use, articles of commerce, recognized as staple merchandise, in fact for any casting which would have a market value as a manufactured article, should be classed equal to new or cost of reproduction."

The insurance companies have striven to influence legislation so that the assured assumes the responsibility of fixing the amount of policy which has no bearing on the amount of payable loss. It is not until the loss occurs that the insurance company takes up the question of valuation.

The underwriters claim that it would not pay the insurance company to fix the values on patterns or any other class of property as this would entail the employment of an expert at say $25.00 per day to go and make such valuation. This expense would be more than equal to the insurance premiums received. Besides, the value of the patterns at the time of insuring would not be identical with their value at the time of the fire. The insurance company will not accept without question the foundryman's valuation and in case of loss, if the amount warrants the expense, the opinion of an expert is obtained to determine if the claim for loss is excessive.

Insurance policies usually include a clause which stipulates that in case of loss, if the insurer and assured fail to agree upon

an adjustment, the matters in dispute shall be submitted to arbitration and in case the parties voluntarily proceed to settle their disputes in this way, the court will enforce the award when so made. In case, however, the assured is not willing to arbitrate, any dispute becomes a question for the court to decide. The insurance companies as a rule taking their time in law suits, the adjustment of a claim this way is seriously delayed and it is found perhaps more advantageous to effect an early settlement by arbitration. In such case the underwriters will, for their own credit, appoint a first class man and the assured will of course make the best selection he can. By these means the final decision is usually a just and equitable one.

The records show that the insurance companies contest from 1 per cent. to 2 per cent. of losses incurred.

It is a peculiar condition that while insurance officials object very much to the "valued" policy in a general way, a number of them favor the adoption of its principles in the question of insuring patterns. As one worthy president of a prominent insurance company puts it: "We would much prefer to take the foundryman's idea of the value of patterns before the fire, rather than after it. His ideas are generally more conservative as to value at the time of taking out policy, having the premium to pay. If the insurer should have a schedule of his patterns made out, putting a value upon each pattern and attaching such schedule to the insurance policy, we would be more inclined to accept the valuation given in such schedule than under any other method of adjusting pattern claims.

In practice it is not advisable for the assured to issue a schedule of patterns and prices to be attached to policy as there are so many changes liable to exist among the patterns, new ones taking the place of old ones, etc. The foundryman would not have the margin of "give and take" in adjusting such matters if each pattern insured was scheduled any more than if he should go by the exact schedule of his general inventory taken at the time of issue of policy. Such schedule would be radically changed although the actual total value of property might not show much variation at the time of loss, in comparison with the amount of insurance agreed upon.

In case of casualty the insurance company is under contract to either reproduce the articles lost in as good a condition as they

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were before the fire or to refund in cash the cost of their reproduction. The value is based upon the market selling price at the time of loss. The law holds that if the property does not command a ready market, the price which it would bring at a present sale would not be considered a fair criterion of value, but the cost required to replace it, in its condition before the fire, would be considered the true value. Accordingly any pattern in active use and in fit condition for moulding, producing a satisfactory casting, is as good as a new one and worth as much.

Probably the most systematic method of establishing the true value of patterns to be used as an inventory for figuring up the firm's assets, or to serve as a schedule giving a true record of patterns at the time of fire, is to keep a pattern book in which should be recorded the name and number of each pattern, its cost, or value, all entered in columns under classfied headings of active, active worn, semi-active, emergency, and obsolete. Every pattern broken up or rendered worthless to be taken from such schedule, every new pattern added, to be entered. Patterns which might be safely considered as obsolete should be charged off. This classification is to be made upon some fixed basis.

The following may serve to suggest the general classification of the various patterns in regard to their durability and earning power. There should be no depreciation charged against an active pattern. To be useful it must be kept as good as new, as it is a most unprofitable policy to work with patterns in any other than the best possible condition. Patterns classed as active worn are those which are not sufficiently worn to be considered out of service.

The active worn pattern should be determined in accordance with the wear and probable extent of durability. The foundryman's judgment must be relied upon in classifying, but a 50 per cent. depreciation should be charged off, in case the pattern should be considered sufficiently worn to warrant its transfer from the active list. In making up the valued schedule the premium to be paid on the amount of risk will tend to make the classification come well within conservative lines.

The customer's patterns should be considered active.

If service is liable to be required at any time, the semi-active pattern is worth the cost of a new one as its earning power would be the same as if new. It is, however, advisable to deduct a fair

depreciation from a pattern of this class, say 15 per cent. per annum, as with the rapid development, in all mechanical pursuits the patterns of to-day are liable to be obsolete in from five to ten years. If, however, the pattern is one which has been made for a certain part of machinery in service but only required for use in case of breakdowns, such pattern should be classed as "emergency" and be charged with depreciation according to its durability and earning power. To establish a fixed basis for valuation the rate charged off should be 25 per cent. per annum.

If a pattern has been made to fill a customer's order for castings, notwithstanding the fact that this item of its cost has been considered in the charges for the casting, and provided the ownership of such pattern remains with the foundryman, it should be considered an asset, regardless of the conditions under which it was made, and if either active, semi-active or emergency, it should be entered and considered upon its classified basis of valuation without discrimination.

When the casting made from a pattern is not liable to be put to further service, or if the pattern is for a machine or a portion of one which has been thrown out of service, and abandoned, such pattern is useless and obsolete.

Obsolete patterns which could be applied to other uses than those for which they were originally intended should be considered as of little or no value, as they would require more or less altering before available and are "dead-wood" until brought into active service again.

An active pattern may pass into semi-active, if the demand for its use falls off and it may eventually become obsolete, if found of no further service, although its condition may be good. An annual survey would determine all this and lead to a revision of the schedule, but if in the interval a fire should occur the face value shown by this schedule should be accepted as shown.

These principles apply equally well for insurance regulation under either "Standard" or "Valued" forms of policy.

In regard to customer's patterns, unless there is a special clause in the policy whereby the insurance company agrees to cover and include in its risk "the patterns held by the assured, the property of others for which the assured may be responsible." the customer's claims will not be recognized by the insurance company. The insurance company insures the owner of the

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goods and not the goods, hence the question of ownership is of vital importance in the settlement of a loss. No one can insure that which he does not own or for which he is not responsible.

If a customer sends his patterns to a foundry to be used for making castings and there is no specific guarantee given by the foundry assuring responsibility for such patterns, the foundry does not become liable for the loss in case of fire. The insurance companies hold that you cannot make a contract for them and they do not agree to insure the customer's patterns unless there has been a special arrangement assuming the responsibility for such patterns, and the policy issued to the foundryman does not accordingly cover the property. The law holds that where the property is held for the benefit of both baylor and baylee, or in other words, customer and foundryman, it is reasonable to expect ordinary care from a man of ordinary prudence. If upon the request of the baylor or customer for his property, the foundryman states that he cannot make delivery of the property as it was destroyed by fire, then to recover, it will be necessary to show that such fire was due to the foundryman's negligence. The burden of the proof is on the customer to show that it was due to negligence on the part of the foundryman before the responsibility can be fixed. The various legal quicksands in the question of protecting the customer's patterns, make it advisable to have the customer insure his property in his own name, distinct and clear from the insurance policy taken out by the foundry. By the customer taking out a policy for the patterns in his own name, all questions as to the title of his property would be carefully defined and he would not run the risks of the foundry failing to come under the average clause. The customer can insure his patterns to their full value and the insurance companies would, under the circumstances, accept the risk without including insurance on other property, thereby in case of loss, the customer is in a much better position for readily adjusting his claims.

The customer's patterns when held by the foundryman are similar as a fire risk to the conditions under which the marine policy serves. They are held by, and subject to, the control of others and the policy should have valued schedule attached, as all the patterns sent to a foundry for use must be considered "active" and of value equal to the cost of replacing.

The transfer of patterns via railroad or other common car-

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riers need not involve the question of fire insurance, as it is a part of the duty of the common carrier to assume this risk for the owner. When the shipment is accepted in good order the transportation company agrees for a consideration to deliver the goods in like condition at stipulated point of delivery.

The insurance companies generally admit that in case of destruction of patterns by fire they have no fixed basis of adjustment of a loss nor method of charging off for depreciation. They proceed to make settlement upon the most equitable basis between the assured and themselves. It would be of great advantage if an established basis of valuation could be pre-determined by both parties. The foundryman insures according to his ideas of value, frequently the adjuster's deductions in case of loss cut a wide margin from the item in policy, covering patterns. The amount of premium which the foundryman has been paying based upon its valuation has been probably duplicated for many years.

An established system of valuation would have saved this excessive outlay. The insurance companies having received more premium than actually due them through such over-valuation. The opinions expressed by a number of influential insurance officials indicate that the underwriters would co-operate in formulating and adopting some fair and equitable basis for appraising the value of patterns. Such valuation to hold good in the adjustment of claims for loss.

It is the object of this paper to bring before the members of this Association the advisability of adopting rules, governing questions of insurance. It is within the province of this Association to establish trade regulations defining clearly what should be considered as active, semi-active, emergency and obsolete patterns; also to determine what would be the reasonable amount to charge off for depreciation on patterns under certain classifications and to define the trade meaning of the term "obsolete" as applied to patterns, also decide if it is the duty of the foundryman to insure customer's patterns. Rules governing these points, if recognized by the American Foundrymen's Association, would be legally construed as a law and usage of the trade, and the insurance policy having pattern clause attached, making valuation of patterns subject to the basis adopted by the American Foundrymen's Association, would be a service to both the underwriter and the assured.

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The New York Produce Exchange has fixed rules and regulations governing the many trades carried on by its members and all contracts made by them are subject to such rules. The American Foundrymen's Association can in the same way, create system out of a chaos. Our members come from all parts of the Union. The scope of the organization is national, and there is no reason why the Foundrymen's contracts cannot be drawn subject to the rules and regulations of the American Foundrymen's Association, and thereby establish a uniform basis of business relations which experience has proven to be so beneficial to the members of other organizations.